



## Pacific Operational Science & Technology Conference

2-4, April 2007

Honolulu, HI

### Agenda

#### Tuesday, 3 April 2007

##### Current Theater Environment – FY07-FY09

###### HQ USPACOM

- **USPACOM J2**, “*Intelligence Prospective*”, *RADM Andrew M. Singer*, USN, Director for Intelligence, J2, US Pacific Command
- **USPACOM J4**, “*Logistics, Engineering, and Security Assistance (J4)*”, *Brigadier General Kenneth S. Dowd*, USA, Director for Logistics, Engineering and Security Assistance, J4, US Pacific Command

##### Homeland Security Perspective:

- **Department of Homeland Security**, “*DHS Science & Technology: Alignment for Success*”, *Rear Admiral, (Retired), Jay Cohen*, USN, Under Secretary for Science & Technology

##### International Perspective:

- **Australia**, “*Current Theatre Environment An Australian Perspective*”, *Dr. Roger Lough*, Chief Defense Scientist, Defence Science and Technology Organization
- **Singapore**, “*Security challenges from the perspective of a small city state*”, *Rear Admiral (Retired) Richard Lim*, Chief Executive, Defence Science and Technology Agency
- **Republic of Korea**, “*Perspective on S&T Collaboration*”, *Dr. Tae In Choi*, Vice President, Agency for Defense Development

##### Banquet w/Special Guest Speaker:

“*Breakthroughs, the Product of Innovators*”, *Mr. Burt Rutan*

#### Wednesday, 4 April 2007

##### Near Term Solutions to Current Challenges – How the World will Change: FY07-FY09

###### *Military Services Research and Development*

- **Army Research and Development**, “*Army Science & Technology Overview*”, *Dr. Thomas H. Killion*, Deputy Assistant Secretary for Research & Technology/Chief Scientist, Department of the Army.
- **Navy Research Enterprise**, “*Naval Science and Technology Update*”, *Rear Admiral William E. Landay, III*, USN, Chief Naval Research
- **Air Force Research and Development**, “*Solutions to Current Challenges: FY07-FY09*”, *Major General Ted F. Bowlds*, USAF, Commander, Air Force Research Laboratory

###### DoD Agency Research and Development

- **DARPA**, “*DARPA Networking and Communications Overview*”, *Dr. Larry B. Stotts*, Deputy Director, Strategic Technology Office, DARPA

- **OSD/Nuclear, Chemical, Biological,** “*Nuclear, Chemical and Biological Defense Research and Development*”, *Dr. Thomas Hopkins*, Acting Assistant to the Secretary of Defense (NCB)

**Lunch w/Guest Speaker:**

“*Strategic Challenges in the Asia-Pacific Area*”, *Lieutenant General (Retired) E.P. Smith*, USA, Director, Asia-Pacific Center for Security Studies

**Industry Panel:**

**Panel Members:**

- **ISR-UAVs,** *Future Solutions – ISR*”, *Mr. John Grabowsky*, VP & GM – Small UAVs, AeroVironment
- **Maritime Domain Awareness,** “*Future Industry Solutions....FY10 and Beyond*”, *Mr. Tom Williams*, VP Advanced Concepts, Integrated Systems Sector, Northrop Grumman Corporation
- **Undersea Warfare,** “*Undersea Warfare*”, *Mr. Roger Bagbey*, SVP & Group Manager – Engineering and Technology Center, Alion Science & Technology

**Game Changing Technology Panel**

**Panel Topics:**

- **Knowledge Management – from SA to BDA,** “*Connecting the Dots*”, *Lieutenant General (Retired) George Fisher*, USA, Director, Department of Defense Programs, National Security Directorate, Oak Ridge National Laboratory
- **Computational Imaging,** “*Game Changing Technologies, Computational Imaging Systems*”, *Dr. Timothy Persons*, Technical Director, Disruptive Technologies, ONI
- **FiberWeb Linear Sensor,** “*The ATLAS, Powered Rope Ascender*”, *Major Rex Blair, USA and Mr. Nathan Ball*, MIT Institute for Soldier Nanotechnologies





# Pacific Operational Science & Technology Conference

*April 2-4, 2007  
Hilton Hawaiian Village  
Mid-Pacific Conference Center,  
Coral Ballroom*

<http://www.ndia.org>



# Pacific Operational Science & Technology Conference

Hilton Hawaiian Village  
Mid-Pacific Conference Center  
Coral Ballroom

## Monday, April 2, 2007

5:00 PM – 6:30 PM	Registration and Ice Breaker Reception Exhibit Hall, Coral Lounge
5:00 PM – 6:30 PM	Exhibits Open, Coral Lounge

## Tuesday, April 3, 2007

*Coral Ballroom IV*

### Pacific Theater Environment: Today and Beyond

7:00 AM – 8:00 AM	Registration Open / Continental Breakfast <i>Exhibit Hall, Coral Lounge</i>
7:00 AM – 8:00 AM	Exhibits Open <i>Coral Lounge</i>
7:20 AM	<b>Administrative Remarks / Conference Overview</b> <i>Dr. Charles H. Kimzey, PhD</i> <i>Science &amp; Technology Advisor, U.S. Pacific Command</i>
7:30 AM	<b>Commander's Overview</b> <i>Lieutenant General Dan Leaf, USAF</i> <i>Deputy Commander, U.S. Pacific Command</i>

### Current Theater Environment – FY07 –FY09

#### **HQ USPACOM**

8:00 AM	<b>USPACOM J2</b> <i>RADM Andrew M. Singer, USN</i> <i>Director for Intelligence, J2, U.S. Pacific Command</i>
8:15 AM	<b>USPACOM J3</b> <i>Brigadier General Martin Post, USMC</i> <i>Deputy Director for Operations, J3, U.S. Pacific Command</i>
8:30 AM	<b>USPACOM J4</b> <i>Brigadier General Kenneth S. Dowd, USA</i> <i>Director for Logistics, Engineering and Security Assistance, J4, U.S. Pacific Command</i>
8:45 AM	<b>USPACOM J5</b> <i>Rear Admiral Michael C. Tracy, USN</i> <i>Director for Strategic Planning &amp; Policy, J5, U.S. Pacific Command</i>
9:00 AM	Panel Discussion <i>Chair: Rear Admiral Michael C. Tracy, USN</i> <i>Director for Strategic Planning and Policy, J5, U.S. Pacific Command</i>
9:20 AM	Break <i>Coral Lounge</i>

# Pacific Operational Science & Technology Conference

## *Homeland Security Perspective*

9:40 AM      **Department of Homeland Security**  
*Rear Admiral, USN, (Retired), Jay Cohen*  
*Under Secretary for Science & Technology*

## *International Perspective*

10:10 AM      **Australia**  
*Dr. Roger Lough*  
*Chief Defence Scientist*  
*Defence Science and Technology Organization*

10:35 AM      **Singapore**  
*Rear Admiral (Retired) Richard Lim*  
*Chief Executive, Defence Science and Technology Agency*

11:00 AM      **Republic of Korea**  
*Dr. Tae In Choi*  
*Vice President, Agency for Defense Development*

12:00 PM      Lunch - Coral Ballroom V  
**Keynote Speaker**  
*Lieutenant General Dan Leaf, USAF*  
*Deputy Commander, U.S. Pacific Command*

1:30 PM – 7:00 PM      Exhibits Open

## **LISTEN UP! Warfighter's Perspective**

1:30 PM      CAPT Kirk Brinker, SOCPAC  
SGM William Smith, USA, HQ USARPAC G357  
EODCS Michael Lentz, USN, EOD MU Five  
CSM Elroy Alcivar, USA, RDCOM  
SSG Keith Frain, USA, Tripler Army Medical Center  
SFC Kevin Kennedy, USA, SOCPAC  
SGM Errol Snyder, USA, 1-21 1-21 Infantry, 25th ID  
SFC Mario Miramontiz, USA, 1-21 Infantry, 25th ID  
SGM George Garcia, USA, 1-21 Infantry, 25th ID  
SMSgt John Anipe, USAF, 25th Air Support Operations Squadron  
SSG Tanner Catrett, USA, 706th EOD  
SSG Brad Joehen, USA, 706th EOD

2:30 PM      **Panel Discussion**  
*Chair: Sergeant Major William T. Kinney, Senior Enlisted Leader,*  
*U.S. Pacific Command*

2:50 PM      **Break**  
*Coral Lounge*

# Pacific Operational Science & Technology Conference

## *"Over The Horizon" Theater Challenges – FY10 and Beyond*

3:10 PM Panel Members: **General Larry D. Welch, USAF (Retired)**

*CEO Institute for Defense Analysis and  
Former Air Force Chief of Staff*

**General Charles R. Holland, USAF (Retired)**

*Former Commander, U.S. Special Operations*

**Admiral Thomas B. Fargo, USN (Retired)**

*President, Trex Enterprises Corporation and  
Former Commander, U.S. Pacific Command*

**Panel Chair: General Larry D. Welch, USAF (Retired)**

*CEO Institute for Defense Analysis and  
Former Air Force Chief of Staff*

5:30 PM Pre-Dinner Social - Exhibit Hall

*Exhibit Hall, Coral Lounge*

6:00 PM Banquet w/Special Guest Speaker – Mr. Burt Rutan

*Coral Ballroom V*

## Wednesday, April 4, 2007

### Solutions to Theater Challenges

*Coral Ballroom IV*

7:00 AM Registration Open / Continental Breakfast

*Exhibit Hall, Coral Lounge*

7:00 – 8:00 AM Exhibits Open

7:50 AM Administrative Remarks / Program Overview

*Dr. Charles H. Kimzey, Science & Technology Advisor  
U.S. Pacific Command*

### **Near Term Solutions to Current Challenges - How the World will Change: FY07-FY09**

#### ***Military Services Research and Development***

8:00 AM **Army Research and Development**

*Dr. Thomas H. Killion*

*Deputy Assistant Secretary for Research & Technology /  
Chief Scientist, Department of the Army*

8:45 AM **Navy Research Enterprise**

*Rear Admiral William E. Landay, III, USN*

*Chief of Naval Research*

9:30 AM **Air Force Research and Development**

*Major General Ted F. Bowlds, USAF*

*Commander, Air Force Research Laboratory*

10:15 AM Break

# Pacific Operational Science & Technology Conference

10:35 AM Panel Discussion –  
***“How the research community can be more responsive to the Warfighter needs.”***  
**Chair: Mr. Vincent Vitto**  
*President & CEO, Charles Stark Draper Laboratory, Inc. and  
Vice Chairman, Defense Science Board*

## ***DoD Agency Research and Development***

11:20 AM **DARPA**  
**Dr. Larry B. Stotts**  
*Deputy Director, Strategic Technology Office, DARPA*

12:00 PM **OSD/Nuclear, Chemical, Biological**  
**Dr. Thomas Hopkins**  
*Acting Assistant to the Secretary of Defense (NCB)*

12:30 PM Lunch w/Guest Speaker - Coral Ballroom V  
***“Strategic Challenges in the Asia-Pacific Area”***  
**Lieutenant General E.P. Smith, USA (Ret)**  
*Director, Asia-Pacific Center for Security Studies*

1:30 PM – 4:00 PM Exhibits Open

## ***Future Industry Solutions – FY10 and Beyond***

### **1:45 PM Industry Panel**

Panel Members: **ISR - UAVs**  
**Mr. John Grabowsky**  
*VP & GM - Small UAVs, AeroVironment*

**Air & Missile Defense**  
**Mr. Dave Kier**  
*VP & Managing Director - Protection  
Lockheed Martin Corporation*

**Maritime Domain Awareness**  
**Mr. Tom Williams**  
*VP Advanced Concepts, Integrated Systems Sector  
Northrop Grumman Corporation*

**Undersea Warfare**  
**Mr. Roger Bagbey**  
*SVP & Group Manager - Engineering and Technology Center  
Alion Science & Technology*

### **2:45 PM Panel Discussion**

Panel Chair: **Dr. Ray O. Johnson**  
*SVP & CTO, Lockheed Martin Corporation*

# Pacific Operational Science & Technology Conference

## ***Game Changing Technologies – Significant Future Operational Solutions***

### **3:05 PM Game Changing Technology Panel**

- Panel Topics:**
- Nano Technology - How Small Can You Go?**  
*Dr. Susan E. Durham*  
*Coordinator for Nanotechnology*  
*Intelligence Technology Innovation Center*
  - Knowledge Management - from SA to BDA**  
*Lieutenant General George Fisher, USA (Retired)*  
*Director, Department of Defense Programs,*  
*National Security Directorate, Oak Ridge National Laboratory*
  - Computational Imaging**  
*Dr. Timothy Persons*  
*Technical Director, Disruptive Technologies, ONI*
  - Directed Energy**  
*Dr. Kirk E. Hackett*  
*Air Force Research Laboratories, Kirtland AFB*
  - FiberWeb Linear Sensor**  
*Major Rex Blair, USA and Mr. Nathan Ball*  
*MIT Institute for Soldier Nanotechnologies*

### **Panel Discussion**

- Panel Chair:** **Mr. Vincent Vitto**  
*President and CEO, Charles Stark Draper Laboratory, Inc.*  
*and Vice Chairman, Defense Science Board*

4:00 PM Exhibit Hall Closes

4:35 PM Adjourn

# ***LOGISTICS, ENGINEERING, and SECURITY ASSISTANCE (J4 )***



***BG Dowd, PhD  
USPACOM J4  
3 APR 2007***

This brief is classified:  
**UNCLASSIFIED**



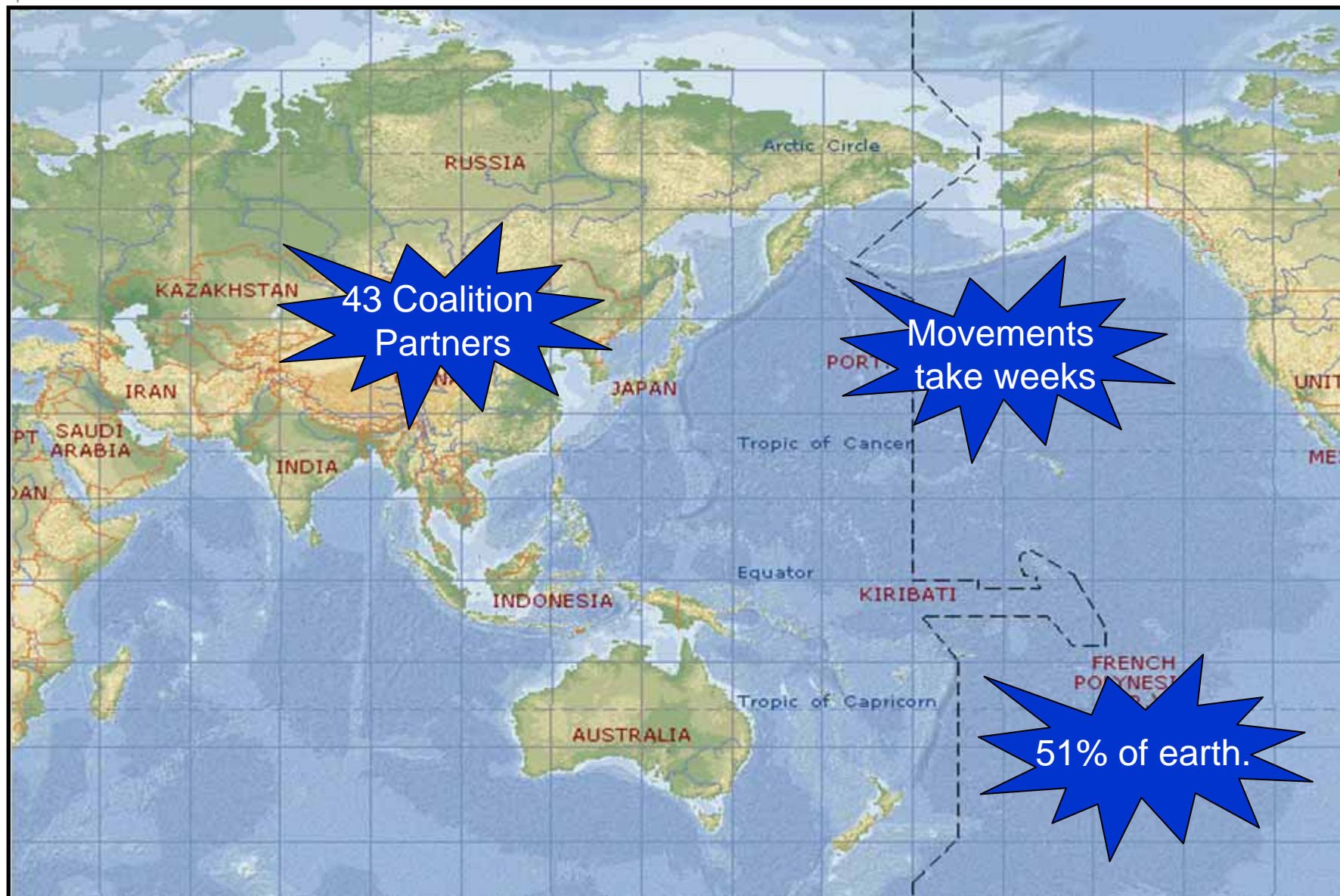
# ***Agenda***

- **The Environment**
- **The Challenge**
- **Discussion**





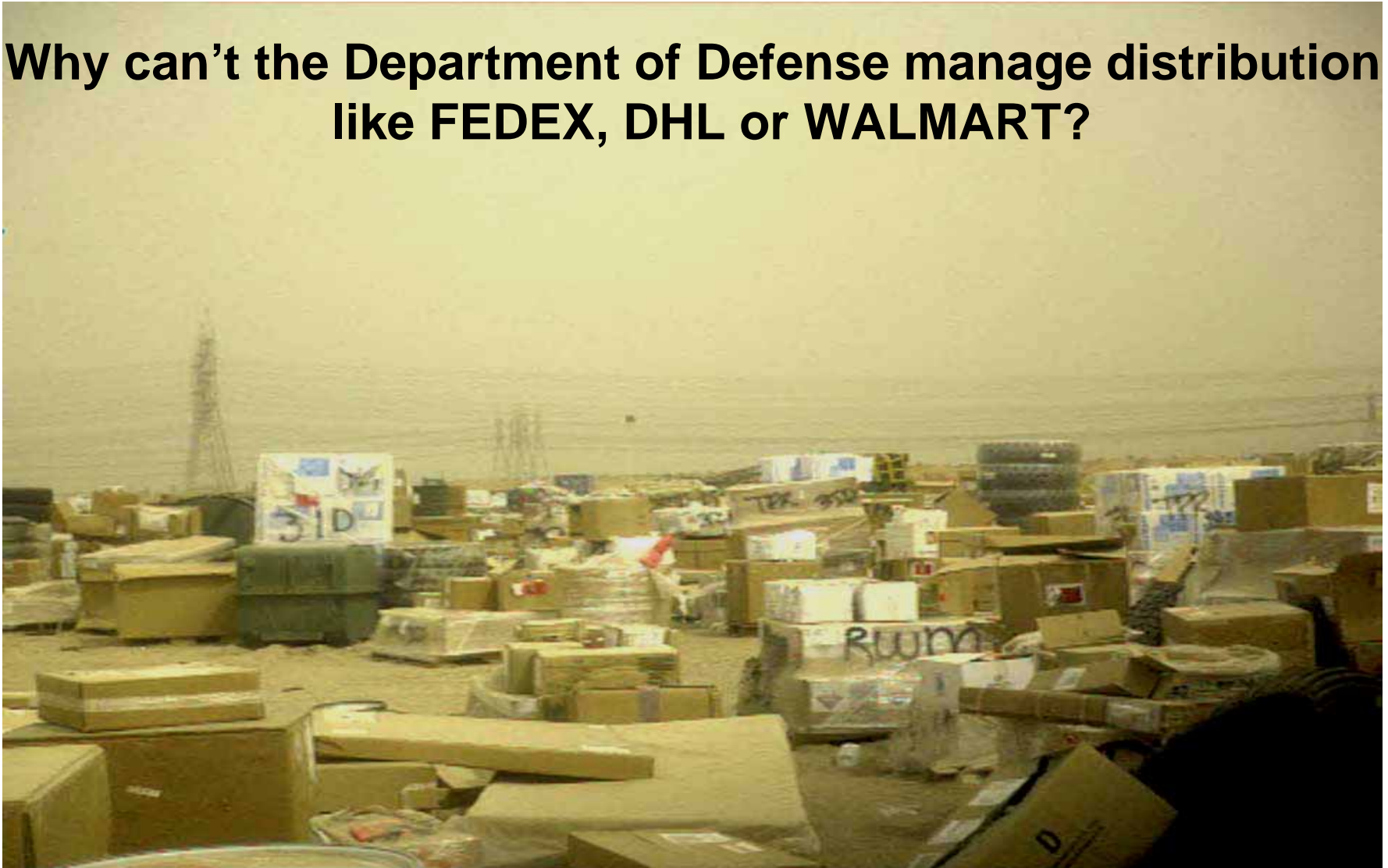
# The Environment





# The Challenge

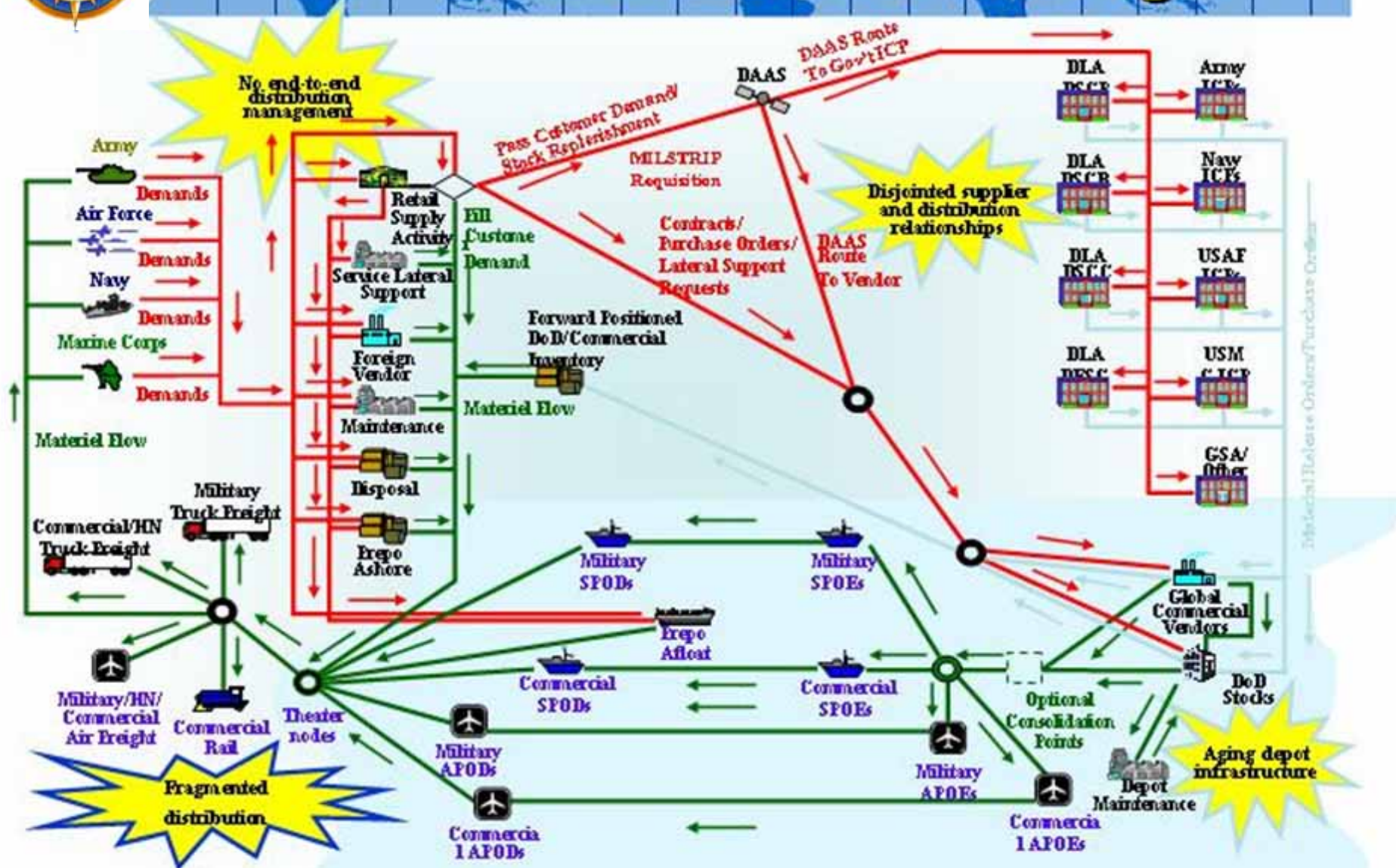
**Why can't the Department of Defense manage distribution like FEDEX, DHL or WALMART?**







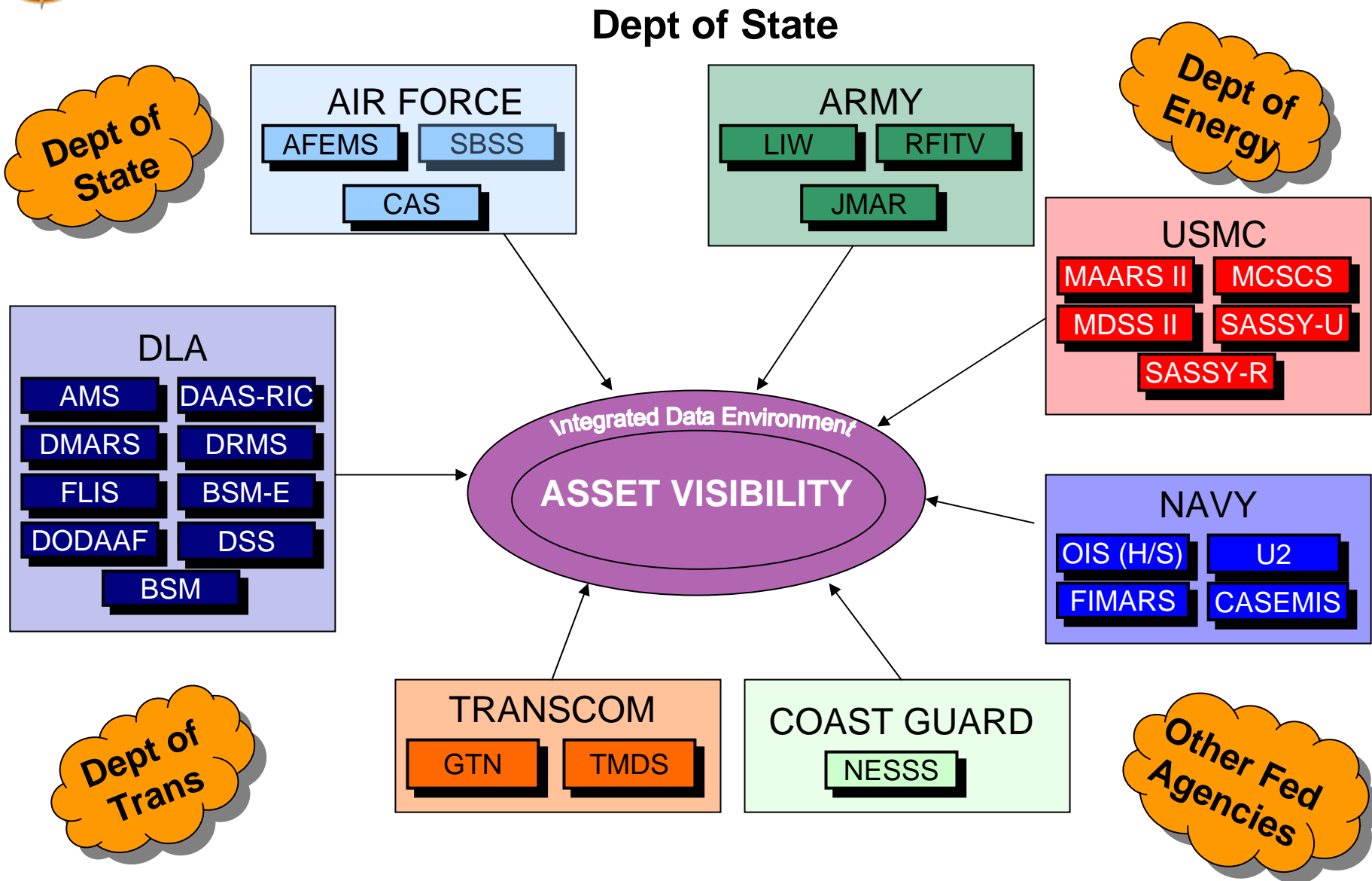
# Distribution Challenge



Does not include AFFES, DECA, Mail, FEDEX/DHL, LOGCAP/Contractor!



# The Automation Challenge – too many systems





# Thoughts

- Money spent on Log Automation \$\$\$.
- Stop Stovepipes
- Joint Funding
- Joint Solutions





# **DARPA Networking and Communications Overview**

**5 April 2007**

**Dr. David Honey**  
Director, STO  
571-218-4247  
david.honey@darpa.mil

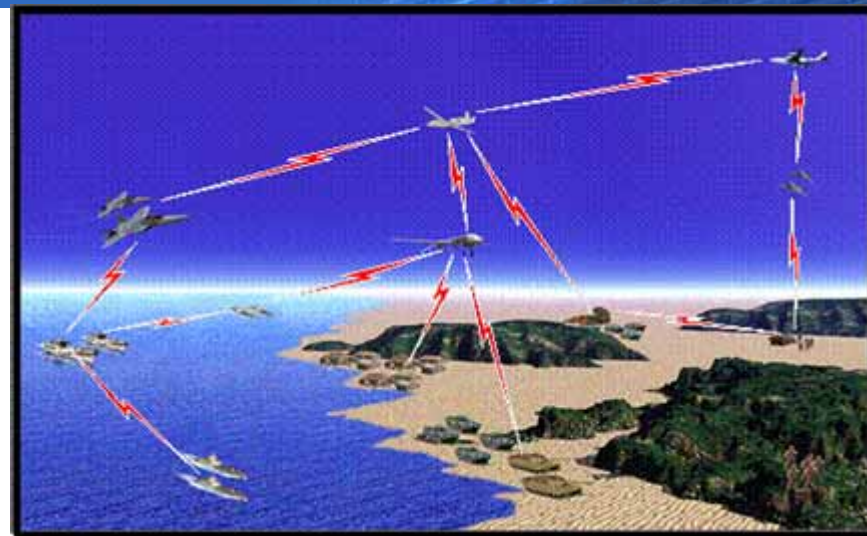
**Dr. Larry Stotts**  
Dep Dir, STO  
571-218-4346  
larry.stotts@darpa.mil

**Dr. Brian Pierce**  
Dep Dir, STO  
703-248-1505  
brian.pierce@darpa.mil

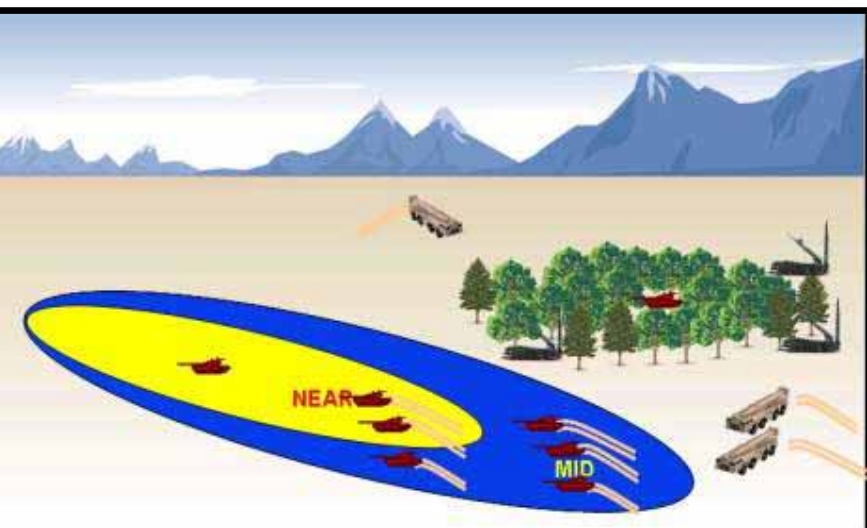
## Network Centric Enterprise

*Strategic and operational level of deployment and warfare*

- Cleared Personnel – TS/SCI
- Links air, ground and naval campaigns
- Engages by operational maneuver and strategic strikes
- Provides information, resources, and sustainment connectivity
- Large C4ISR backbone and infrastructure
  - Rides on GIG and Extensions
  - Can leverage commercial info systems
  - IPv6 early adopter
  - Susceptible to many IA threats



***Bridge the Gap***



## Network Centric Warfare

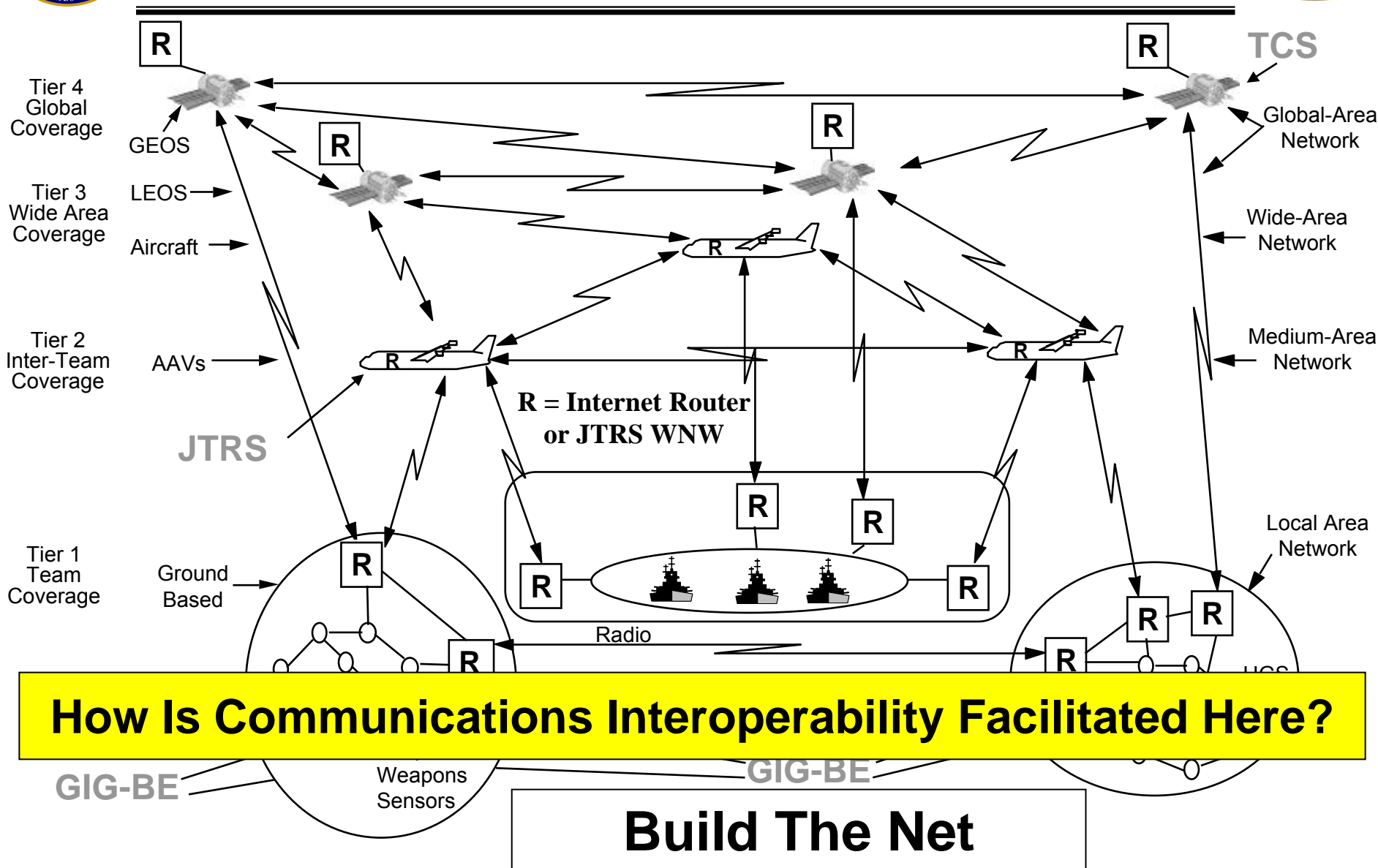
*Tactical level of deployment and warfare*

- Uncleared Personnel
- Links effects to targets
- Engages directly with the enemy
- Must be agile, adaptive and versatile
- Minimal, “portable” C4ISR infrastructure
  - Rides on tactical communications
  - Requires LPD/LPI transmission security
  - NCW weapons susceptible to IA attack





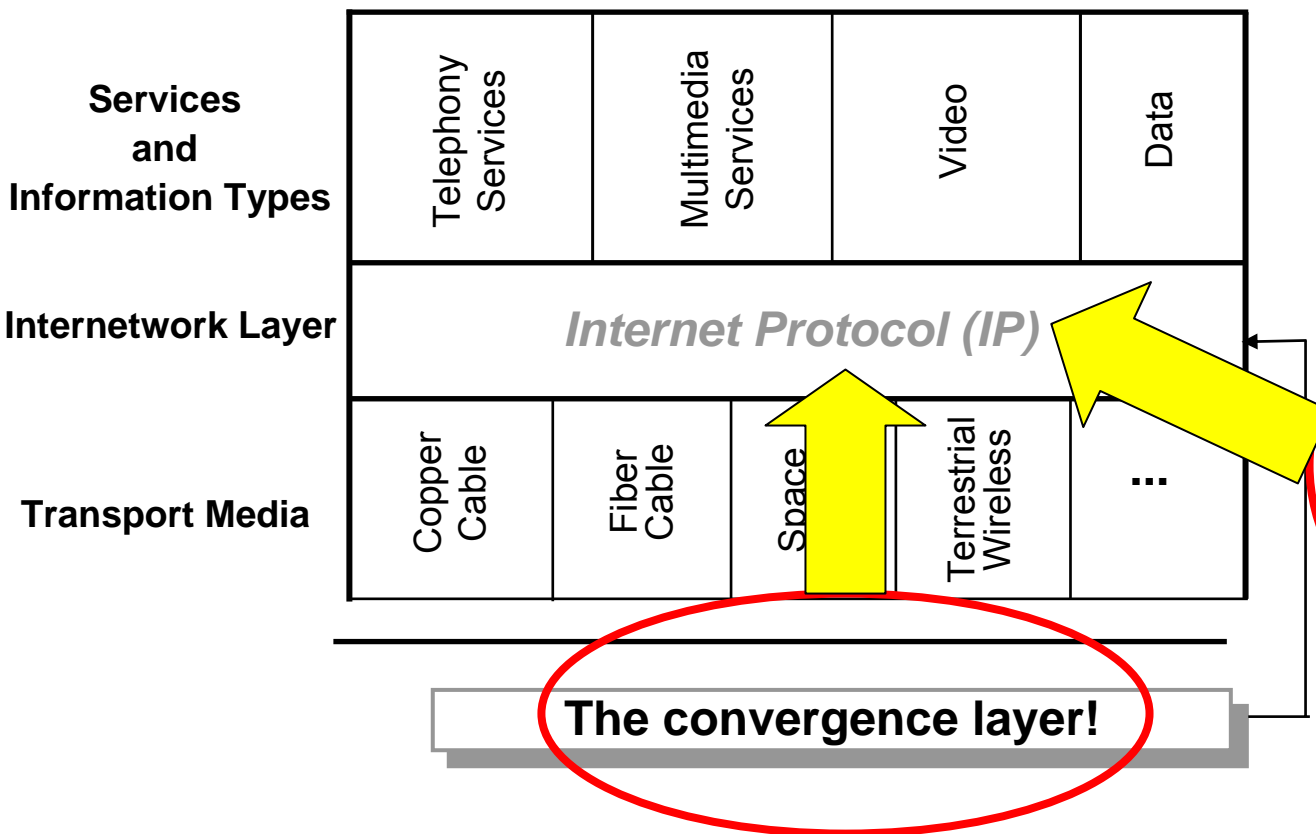
# GIG: Transport Layer







# GIG: IP Based

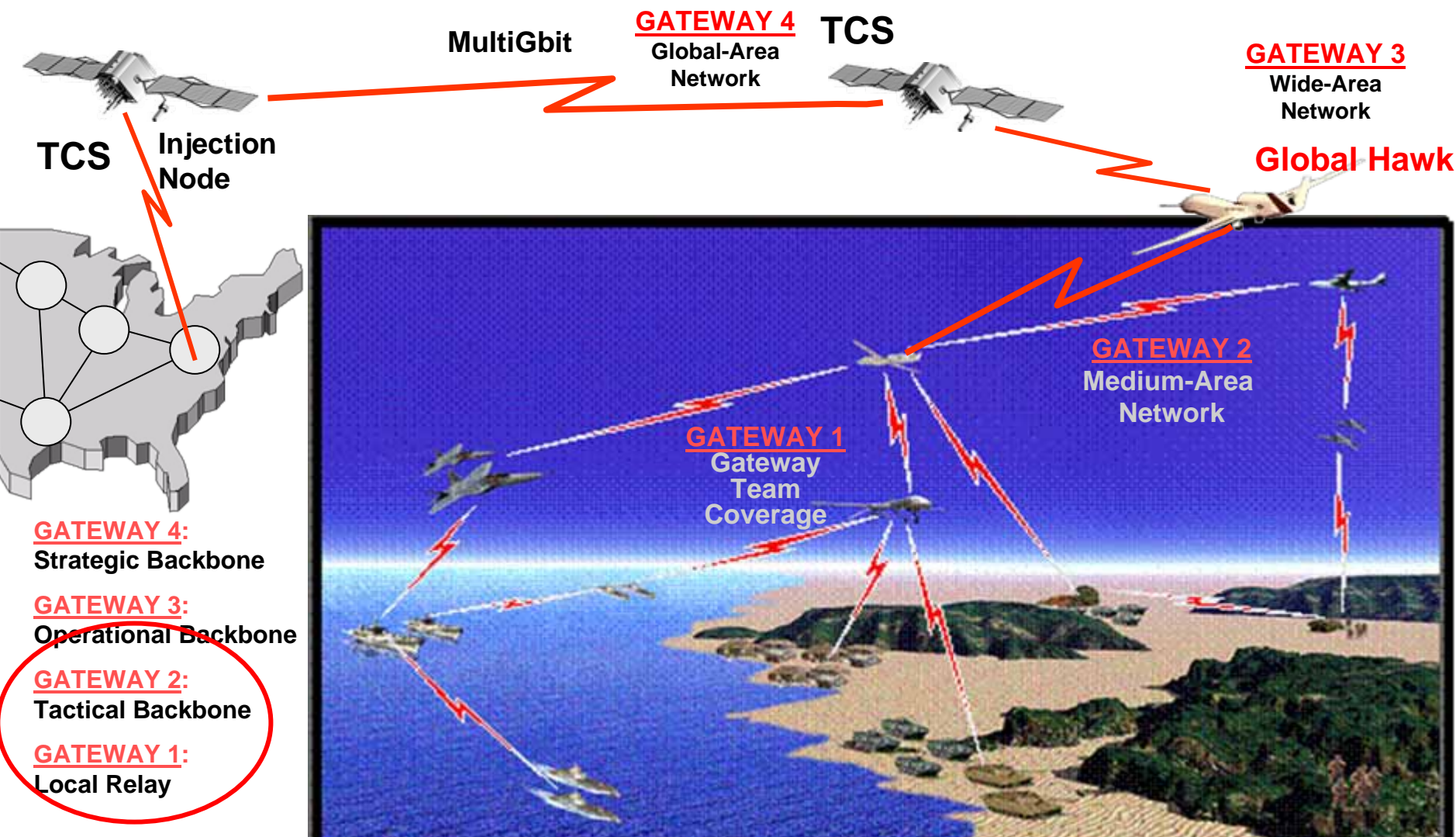


- *World-wide* acceptance and *use*
- *Packet-switched* Internet transport
- Provides *common-user*, integrated services framework
- Provides *standardized interface* between Application and Transport Services
- Used over many network-level protocols (Ethernet, ATM, WAP...)

**Answer: Communications Interoperability via the Network!**



# How Do You Make This Happen: Network Gateways



**Future Combat Systems Communications Network Centric Demonstration**





# Possible Architecture Using DARPA Technologies



Relay to GIG Fiber Optic Point of Presence

Tier 4

Broad Area Maritime Systems

Tier 3

Global Hawk

Tier 3

Joint Strike Fighter

Predator

Tier 2

Tier I

Class III UAV

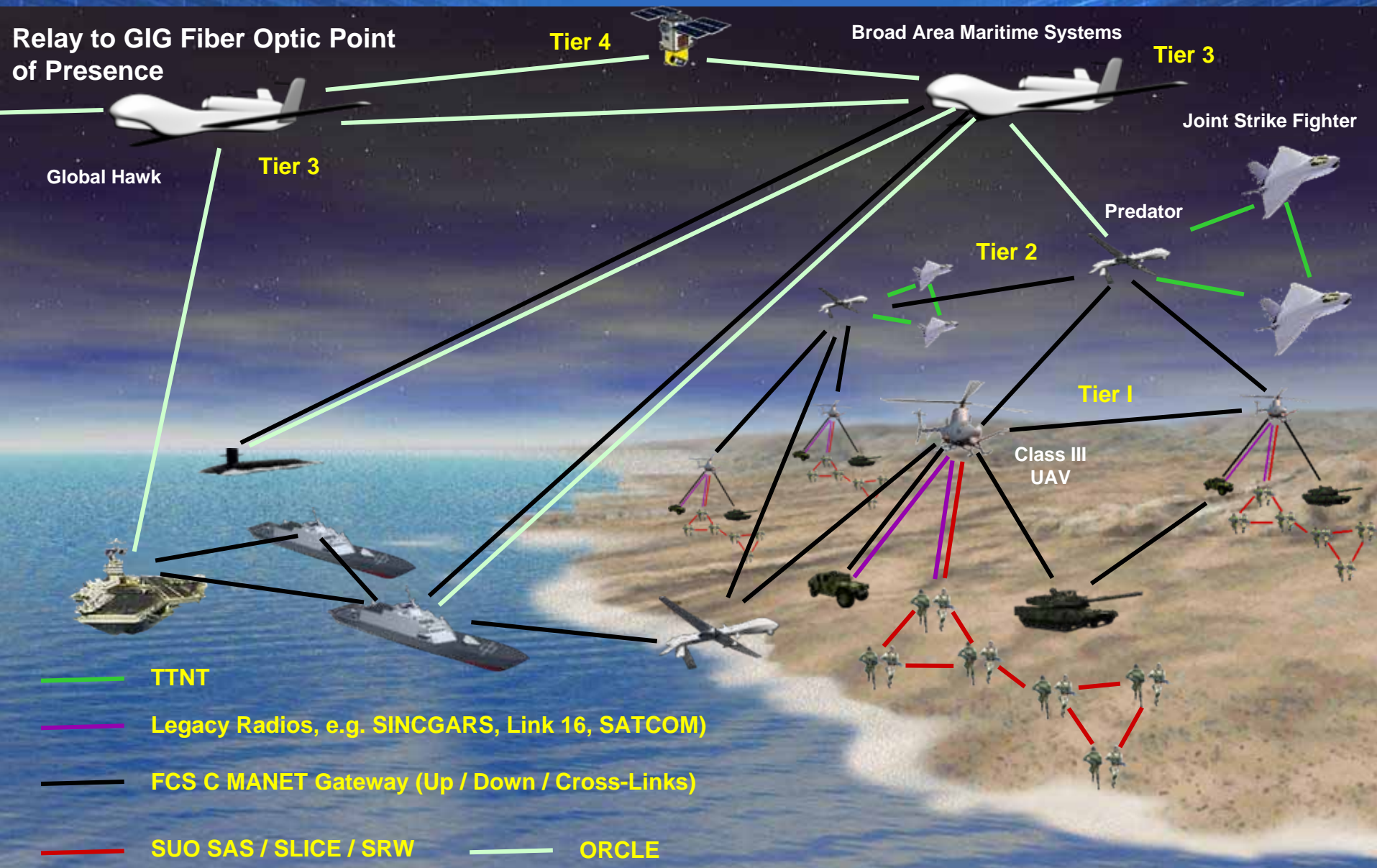
TTNT

Legacy Radios, e.g. SINCGARS, Link 16, SATCOM)

FCS C MANET Gateway (Up / Down / Cross-Links)

SUO SAS / SLICE / SRW

ORCLE







# Optical & RF Combined Link Experiment (ORCLE)

*Links to forces fixed and on the move*



Optical Retro Reflector  
Clear Air  
>45 Mbps  
Uplink/Downlink

FSO/RF  
All Weather  
Surface to 10 km  
>95% Availability  
2 Gbps (average)

Air-to-Air Crosslink  
FSO/RF  
>200 km  
99% Availability  
2 Gbps (average)

**Objective: Develop a hybrid free space optical/radio frequency communications system**

GIG / Fiber Optic  
Point of Presence

Component and Technology Lab Demos: Complete  
Improved Availability Study: Complete  
Technology Maturation: Presently  
MOA with USAF: Signed Sep 2006  
Ground Link and Network Test (Air-Air and Air-Ground): Complete  
Air-Air-Ground Flight Demo (Primary Program Goal): Nov 2007



# Future Combat Systems Communications



## *A Dual-Rate, Mobile Ad-Hoc Network for the Maneuver Force*

Mobile ad-hoc network *dynamically* reconfigures during operations to *automatically* maintain network connectivity

QoS Provides for Adaptive Communications Capabilities

System automatically schedules non-interfering communications for increased network capacity

High Band (JTRS NDL-Like)  
> 50 Mbps rate high band

Spatial re-use improves network capacity

Low Band (JTRS WNW-like)  
> 5 Mbps rate low band

Networked vehicles automatically communicate when within range – no manual configuration

Multi-Mode Connectivity Options:  
GND-to-GND, GND-to-AIR, AIR-to-AIR & AIR-to-GND

Vehicles automatically leave and join the network – no manual entry

*Network Centric Field Experiment at Fort Benning – JAN 2006*



# FCS Communications Technology Highlights



- **Assured high data rate communications:** Simultaneous high data rate networked communications in high and low bands. Adaptive data rates 72 Mbps in high band, 10 Mbps in low band. Spatial re-use through directional antennas for increased network throughput.
- **High resistance to threat jamming:** Directional antennas, supplemented by AV-OFDM waveform in low band and DSSSS in high band. Digital beam forming in low band steers nulls against jammers. Adaptive networking routes traffic around jammers.
- **High resistance to threat detectors and intercept:** Very narrow directional beams in high band; directional beams in low band, with featureless OFDM waveform.
- **Assured multi-path communications:** Low band AV-OFDM waveform integrates over frequency and time, outperforms rake receivers at low cost/weight.
- **QoS based ad-hoc mobile-mobile networking** incorporating the benefits of adaptive waveforms and smart antenna technology in both low and high bands for improved message throughput in threat and non-threat conditions.
- **Validated designs validated through relevant field demonstrations** air and ground mobile nodes including actual military robotic platforms, airborne nodes, surrogate netfires supplemented by critical laboratory modeling and simulation for validation and scalability.





# FCS C Demo 3 Go/No-Go Results



FCS Communications Go/No-Go Metrics	Demo 3 Criteria		Raytheon (FCS-C)	
20 Node Average Network Aggregate Throughput (Goodput)	AJ/LPD	HDR	AJ/LPD	HDR
Low Band	200 Kbps	10 Mbps	203 Kbps	10.3 Mbps
High Band	1 Mbps	70 Mbps	24 Mbps	50 Mbps
LPD/AJ				
Spatial - Low Band (3 dB beamwidth)	45°		39°	
Spatial - High Band (3 dB beamwidth)	3.5° x 12° *		3.5°x12°	
Processing (PG, nulling, etc.)				
Low Band	40 dB		41.6 dB	
High Band	14 dB * (19.4 dB)		19.4 dB	
Latency				
Type 1 (10% of the avg sys load)	90% < 200 msec.			90.0%
Type 2 (30% of the avg sys load)	90% < 1 sec.			88.8%
Type 3 (60% of the avg sys load) (Retrans 3x)	90% < 30 sec.			98.9%
HB/LB Transition		<1 sec.		1 sec.
Packet Delivery				
Type 1 (10% of the avg sys load)		90%		75.0%
Type 2 (30% of the avg sys load)		90%		73.6%
Type 3 (60% of the avg sys load) (Retrans 3x)		90%		88.3%
20 Node Network Initialization Time		<6 min.		2 min.
Node Entry Time		<30 sec.		10 sec.
Detect Node Exit Time		<10 sec.		5 sec.

**Live Test under operational conditions - User level performance**

**NOTE:** Items in Red corrected upon return to lab and GO/NO GO validated in Raytheon Parking Lot



# What Was Demonstrated by the FCS C NC Demo



## 1. Raytheon Network Centric Radio In Operations

- Operates Like WNW would In Network Centric Operations at Tier 1 & Tier 2
- SCA Compliant, Non-Proprietary Software
  - Raytheon Will supply FCS C Waveform Given to JTRS Library as above
- High data rate LOS (including LOS airborne extensions to BLOS) networked radio system
  - >100 km Non-LOS Ranges Achievable with Airborne Relays
  - Automatic Adaptation to Lower Data Rates for Increased Range
- Automated “configuration” and Network Management

## 2. Heterogeneous Gateway Architecture Implemented In TCA Structure

- Gateways linked end-users via Sample WAN technologies
  - FCS-NC, Ku SATCOM, Inmarsat, Iridium, GlobalStar
- Gateways linked end-users via Tactical Data Radios (IP Capable)
  - EPLRS, EPLRS micro-Lite, Soldier Radio Waveform (SRW), SECNET 11
- Gateways linked end-users via Tactical Voice Radios
  - PRC 117, PRC 119, PRC 150

## 3. Complete Soldier Operation In Simulated Missions

- Initial Training in NOV/DEC 2005 at Fayetteville, TN
- Heterogeneous Gateway Operations as well as Surrogate UAV Placement for Optimum Connectivity

***Demonstrated Transformational Communications Down to the Platoon***





# FCS-C Network Centricity Demonstration

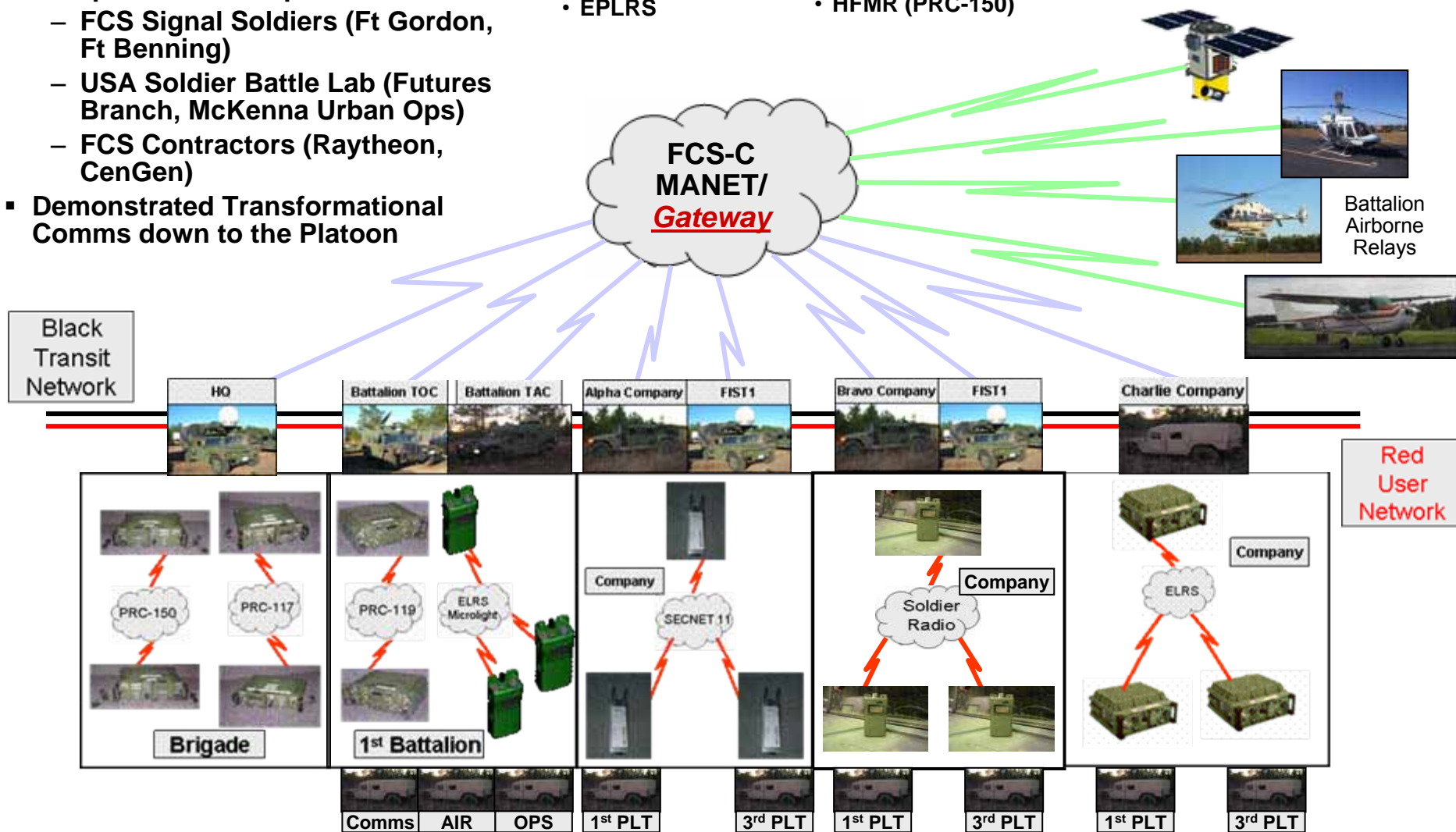
## Network Connectivity with FCS MANET & Gateway

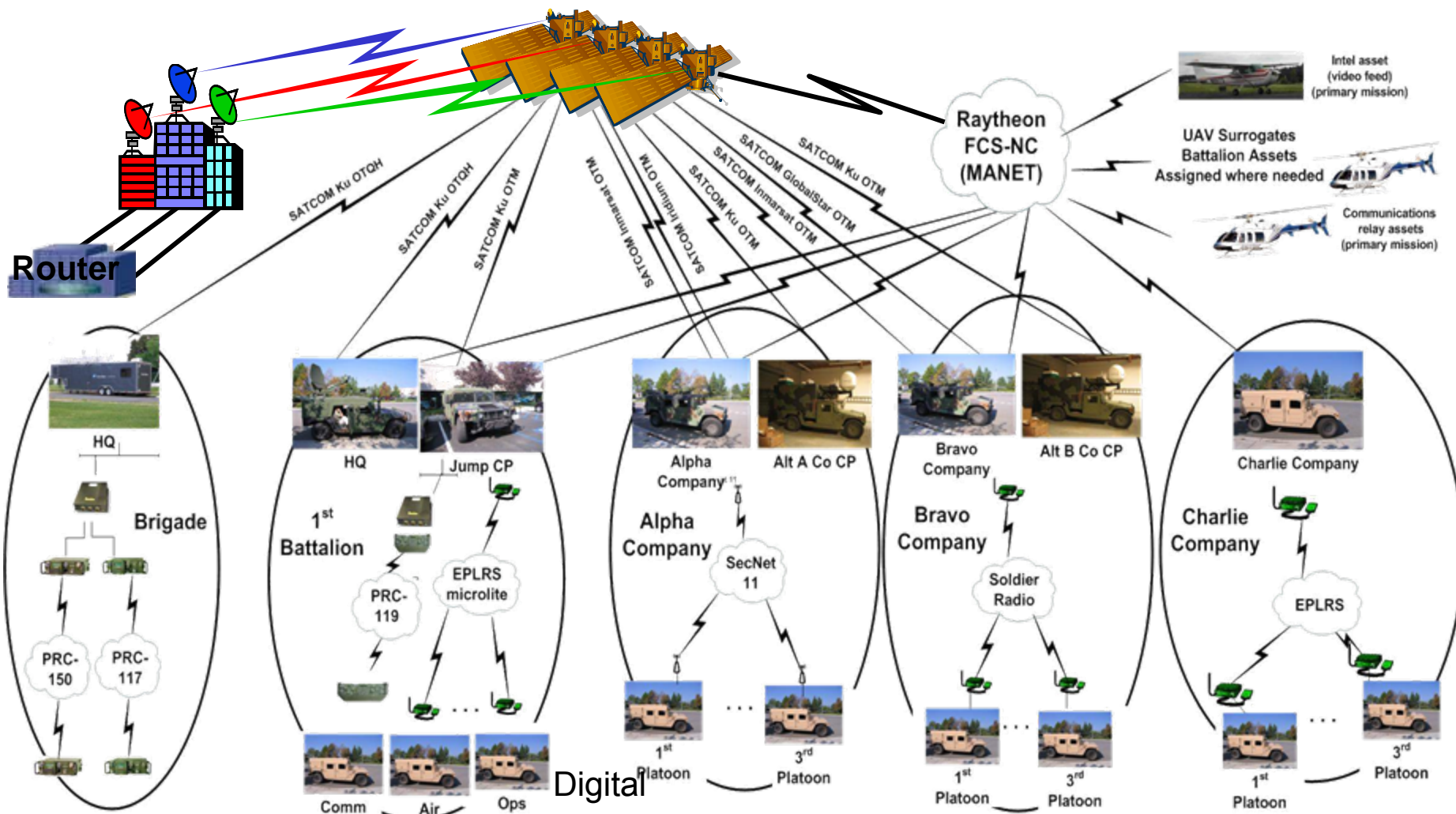


- Network Centric Radio Operations
- Heterogeneous Gateway Architecture
- Complete Soldier Operation
  - FCS Signal Soldiers (Ft Gordon, Ft Benning)
  - USA Soldier Battle Lab (Futures Branch, McKenna Urban Ops)
  - FCS Contractors (Raytheon, CenGen)
- Demonstrated Transformational Comms down to the Platoon

### Interoperable Communications

- CPOF's VoIP
- ITT Soldier Radio
- EPLRS
- HAVEQUICK I/II (PRC-117)
- SINCGARS (PRC-119)
- HFMR (PRC-150)





- Translate everything into IP (Analog Voice to VoIP)
- Interoperate at the Network Layer (OSPF)
- Demonstrated over 120 km-wide scenarios

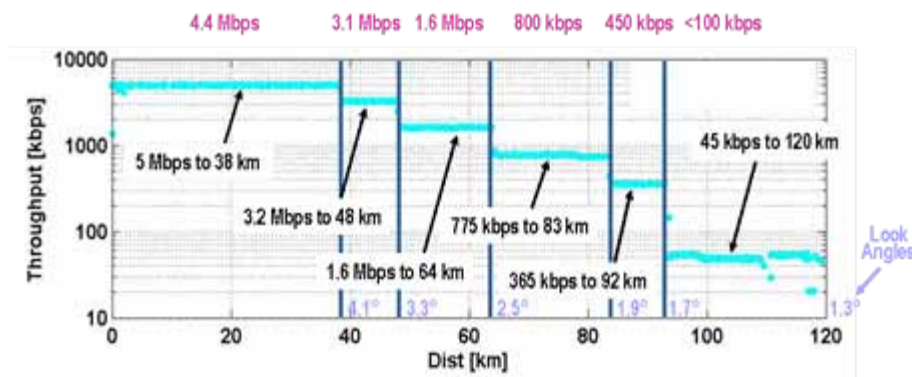


# Comparison of FSC & WNW Performance



Characteristic	Wideband Network Waveform	FCS C MANET / Gateway <sup>2</sup>
Demonstrated Max Data Rate at Max line-of-sight, point-to-point mode	<ul style="list-style-type: none"> <li>• 1 Mb/s @ ~14 miles (Expansion to 2 Mb/s is planned for summer of 2008) <sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>• 5.5 Mb/s @ 23.6 miles</li> <li>• 1.6 Mb/s @ 39 miles</li> <li>• 775 Kb @ 51.6 miles</li> </ul>
Demonstrated Radio Interoperability with Networking	<ul style="list-style-type: none"> <li>• Demonstrated hardware running WNW simultaneously with a JTRS version of a legacy signal, which proves the feasibility of key JTRS concepts, waveform portability and simultaneous waveform operation <sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Simultaneous demo at Ft Benning of MANET/Gateway communications among the following digital and analog systems: CPoF's VoIP, the ITT Soldier Radio, the Enhanced Position Location Reporting Systems (EPLRS), HAVEQUICK I/II (PRC-117), the Single Channel Ground and Airborne Radio System (SINCGARS/PRC-119) and the High Frequency MAN-PACK Radio (HFMR/PRC-150) and various SATCOM Links.</li> </ul>

**Demonstrated FCS C Performance at Ft Benning**



Note: The Army's Joint Network Node was not included in this comparison as JNN is not a tactical MANET system as JTRS WNW and FCS C. It is on-the-halt (Static) SATCOM (non-MANET) and is designed to be integrated into tactical backbone at Brigade fixed TOCs.

<sup>1</sup> Charlotte Adams, "Editor's Note: Reinventing JTRS", *Avionics Magazine Monthly News*, Volume 1 Issue 1, July 17, 2006.

<sup>2</sup> FCS C Network Centric Demonstration, McKenna MOUT Site, Ft Benning, January 2006

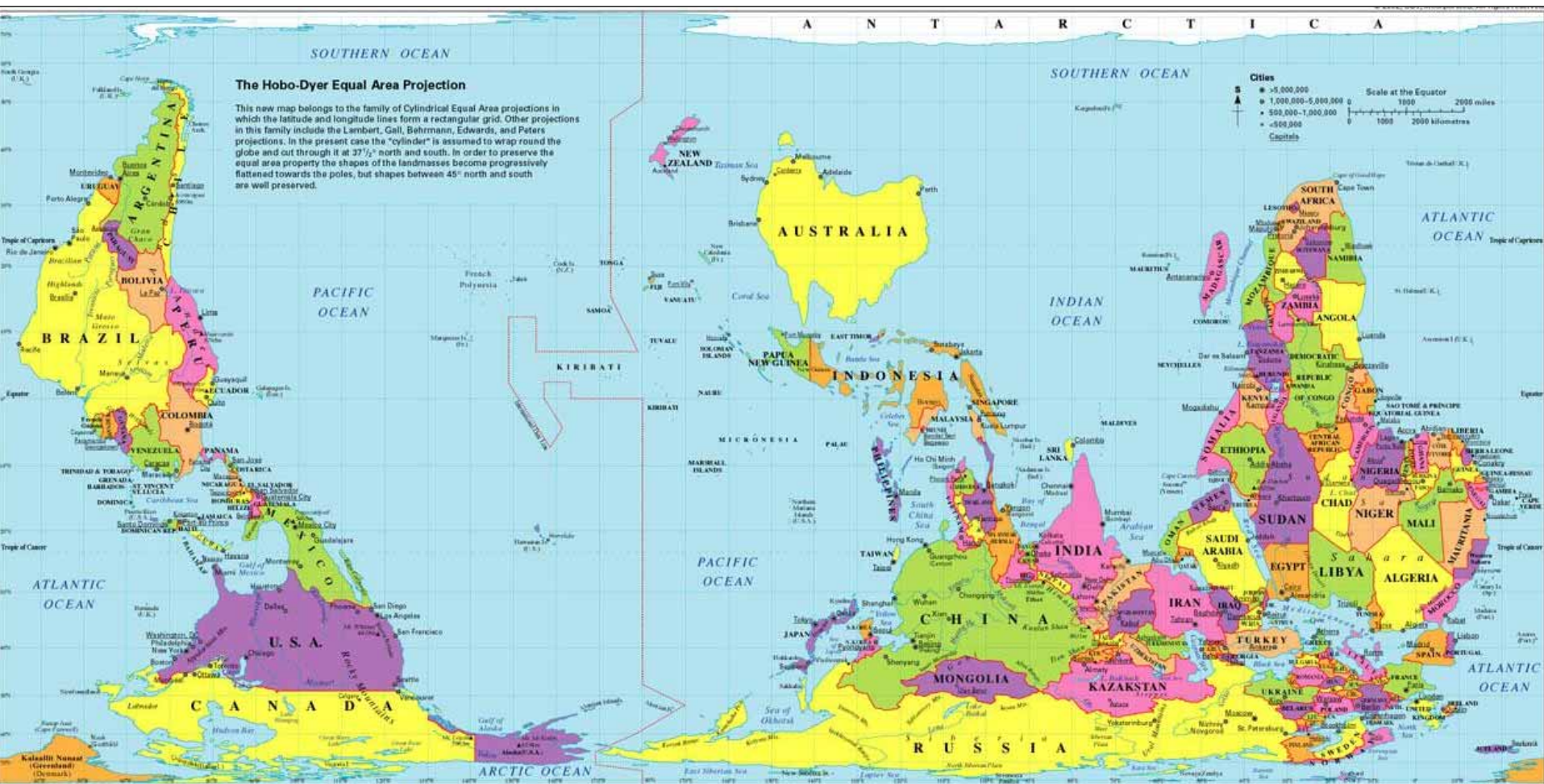




# Current Theatre Environment An Australian Perspective

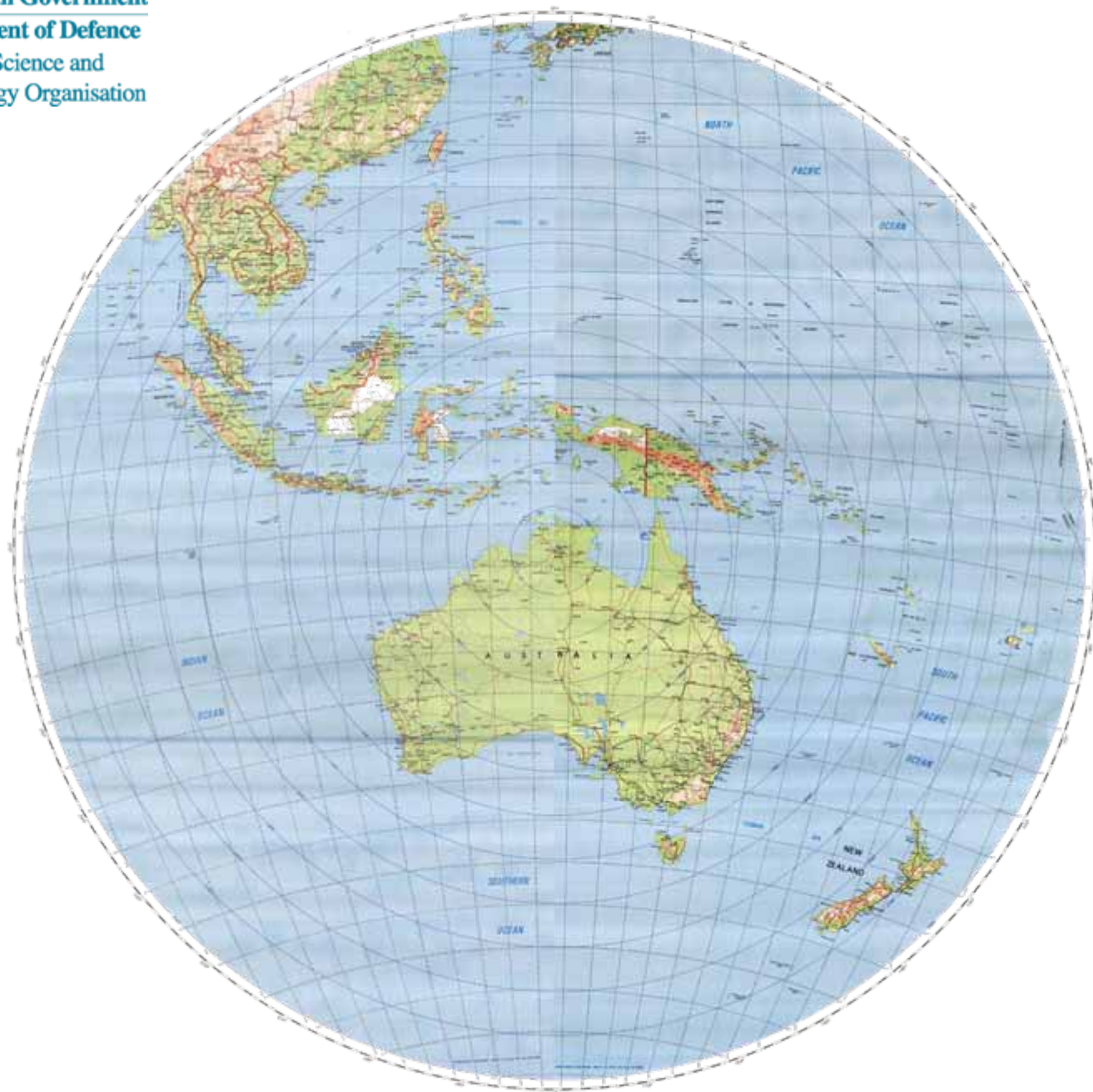
Dr Roger Lough  
Chief Defence Scientist

Pacific Theatre Operational Science and  
Technology Conference  
Hawaii  
April 2007





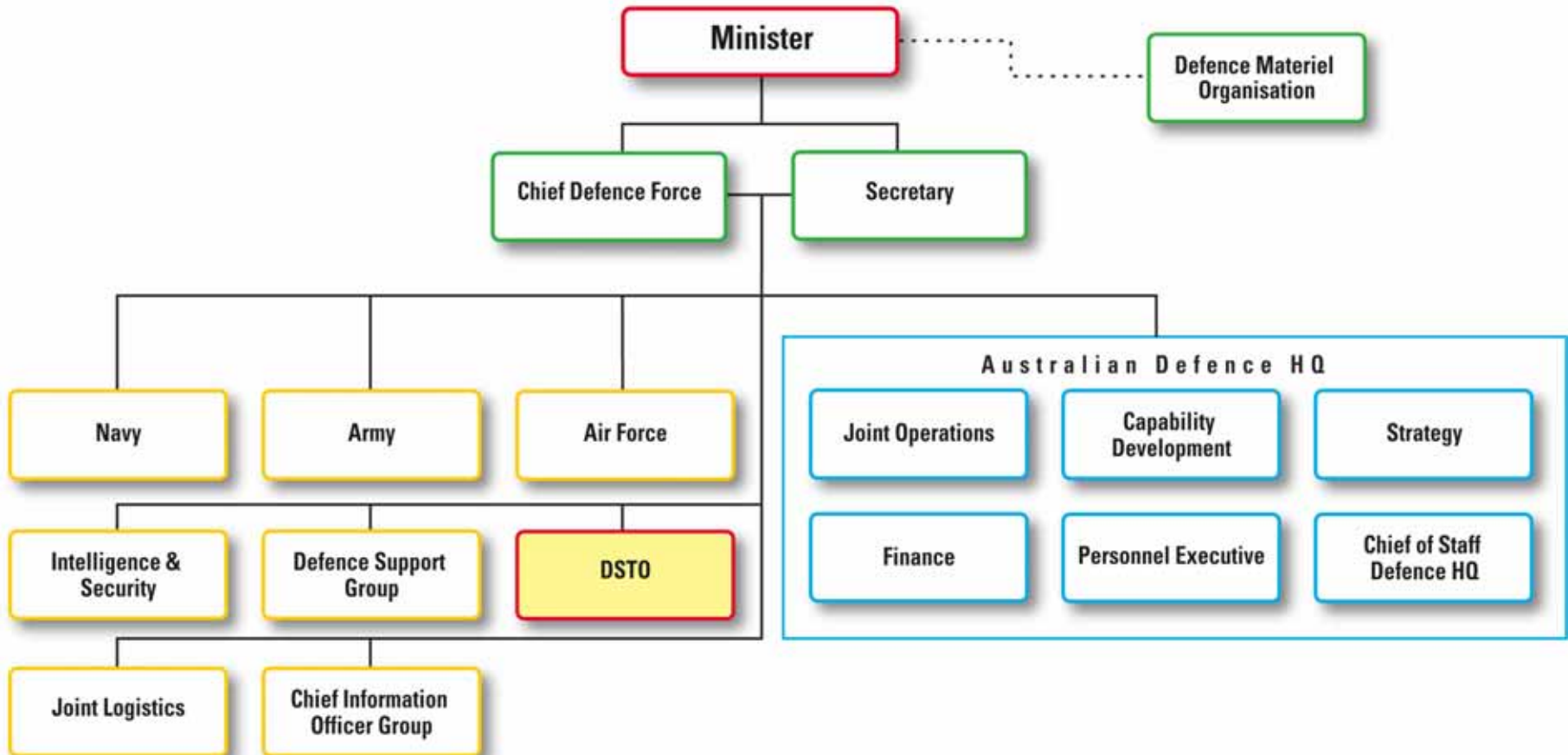
Australian Government  
Department of Defence  
Defence Science and  
Technology Organisation



# DSTO Mission and Vision



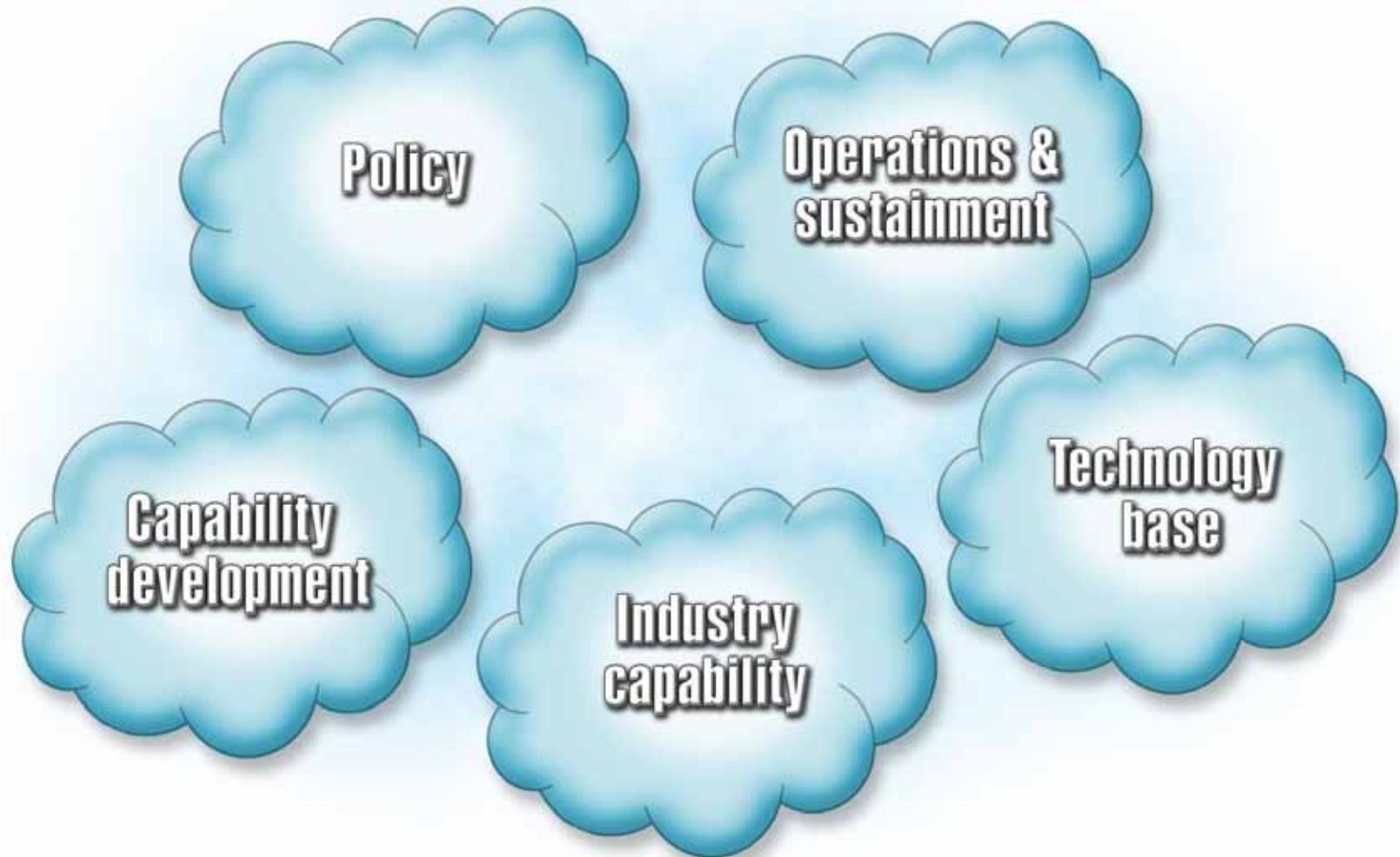
# Defence Structure



# DSTO at a Glance



# DSTO Functions



# Program Thrusts

## Wide Area Surveillance



# Program Thrusts

## Network Centric Warfare





# Program Thrusts

## Interoperability



Joint Australian United States  
Exercise – Talisman Sabre 07

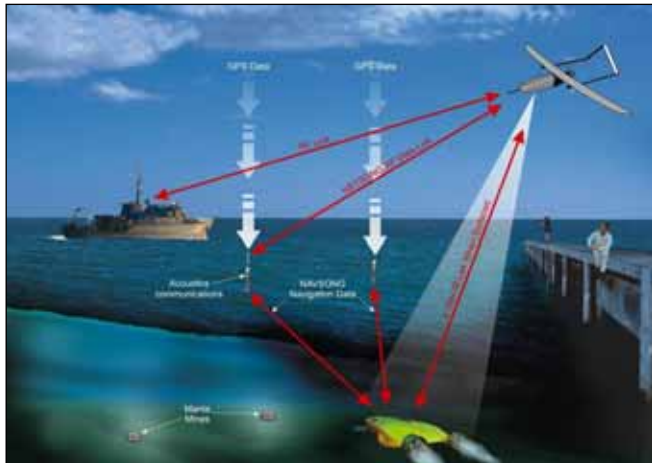


Coalition Readiness Management  
System Project Arrangement -  
CReaMS

# Program Thrusts

## Experimentation

### Automation of the Battle Space Initiative



### Headmark



Headline – Concept Exploration and  
Analysis Laboratory (CEAL)

# Program Thrusts

## Chemical, Biological & Radiological Defence



PC3 Laboratory



Breathable Chemical and  
Biological suit



# Program Thrusts

## Aging Aircraft



Structural test on F/A-18



Smart Structures

# Capability & Technology Demonstrators

- Allows Australian Defence Industry to demonstrate how advanced technology can enhance Defence capability.
- \$160 M invested since 1998.
- Average CTD \$3m; 3 years.



# Capability & Technology Demonstrators



Underwater Personal Computer



Fibre Laser Sonar  
(Hydrophone)



# Capability & Technology Demonstrators



Rassputin Sonobuoy



Cuttlefish – protection of ships  
from radar surveillance



# Emerging Issues



Operational  
Tempo



IEDs



Space  
(Hypersonics)



Intelligence, Surveillance and  
Reconnaissance

# Thank you



# **Perspective on S&T Collaboration**



**Tae-In Choi, Vice President  
Agency for Defense Development**

**Operational S&T Conference**

**PACOM, Hawaii**

**April 2007**

# Overview of Talk

---

- ▶ RoK Battle Lab Status
- ▶ RoK/US S&T Cooperation
  - Examples of Joint Development
- ▶ Conclusion



# Naval Battle Lab.

## Under New SBA System

- The Role of Battle Lab.
- ROKN BL and ADD BL for SBA
- 2007 US-ROK NBE Symposium

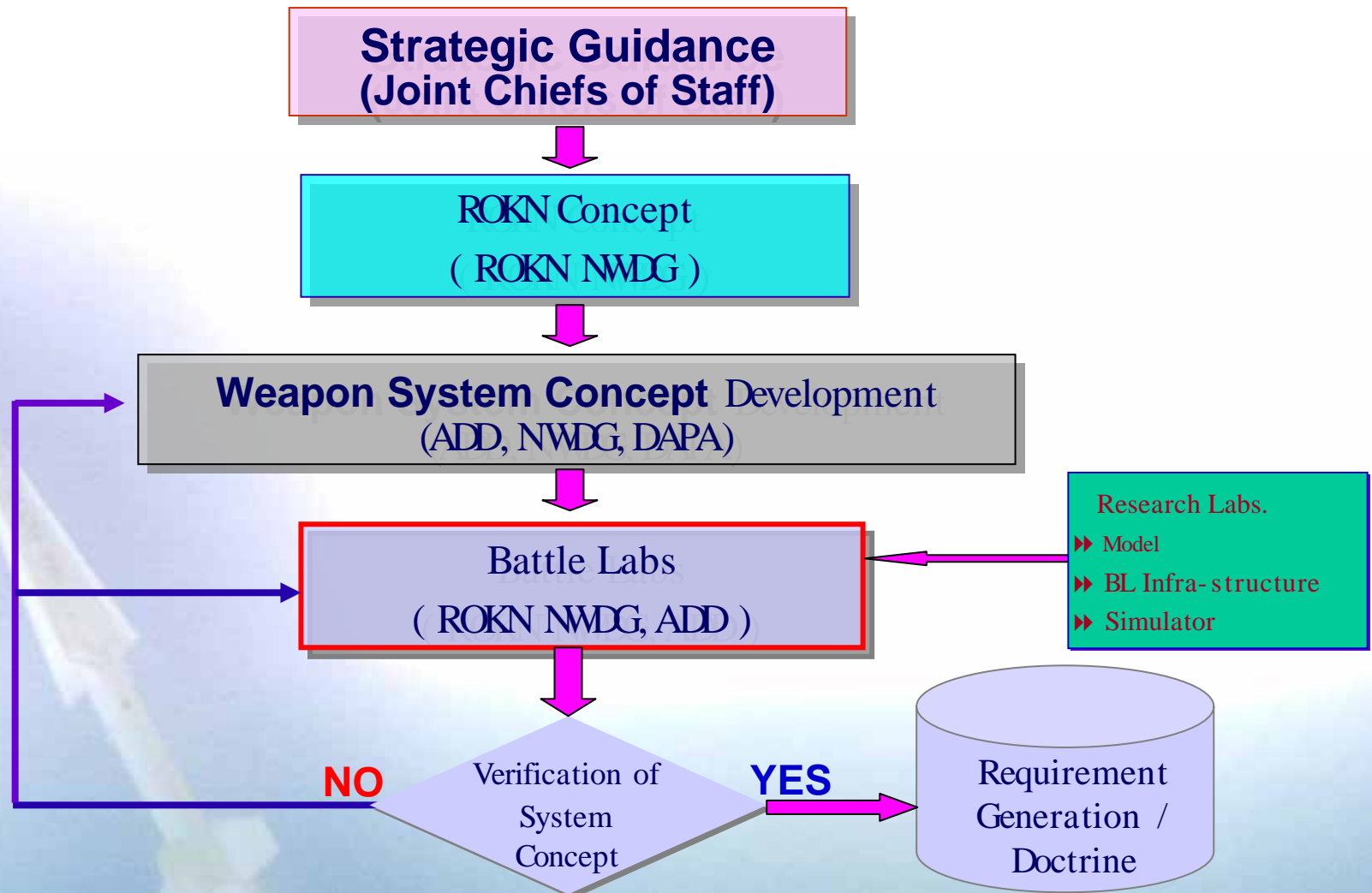
# The Role of Battle Lab. (1 / 3)

## What is Battle Lab?

- A mechanism for assessing New Ideas & Capabilities provided by advanced technologies
- An innovative mechanism for scientific requirement generation based on the operation concepts of future battlefield
- A core verification tool in Top-down/Born-Joint weapon development flow
- Battle Lab needs to be designed to meet diverse requirements as engineering test beds for R&D Program Managers and as simulation tools for field commanders, tactical planners, and war gamers.

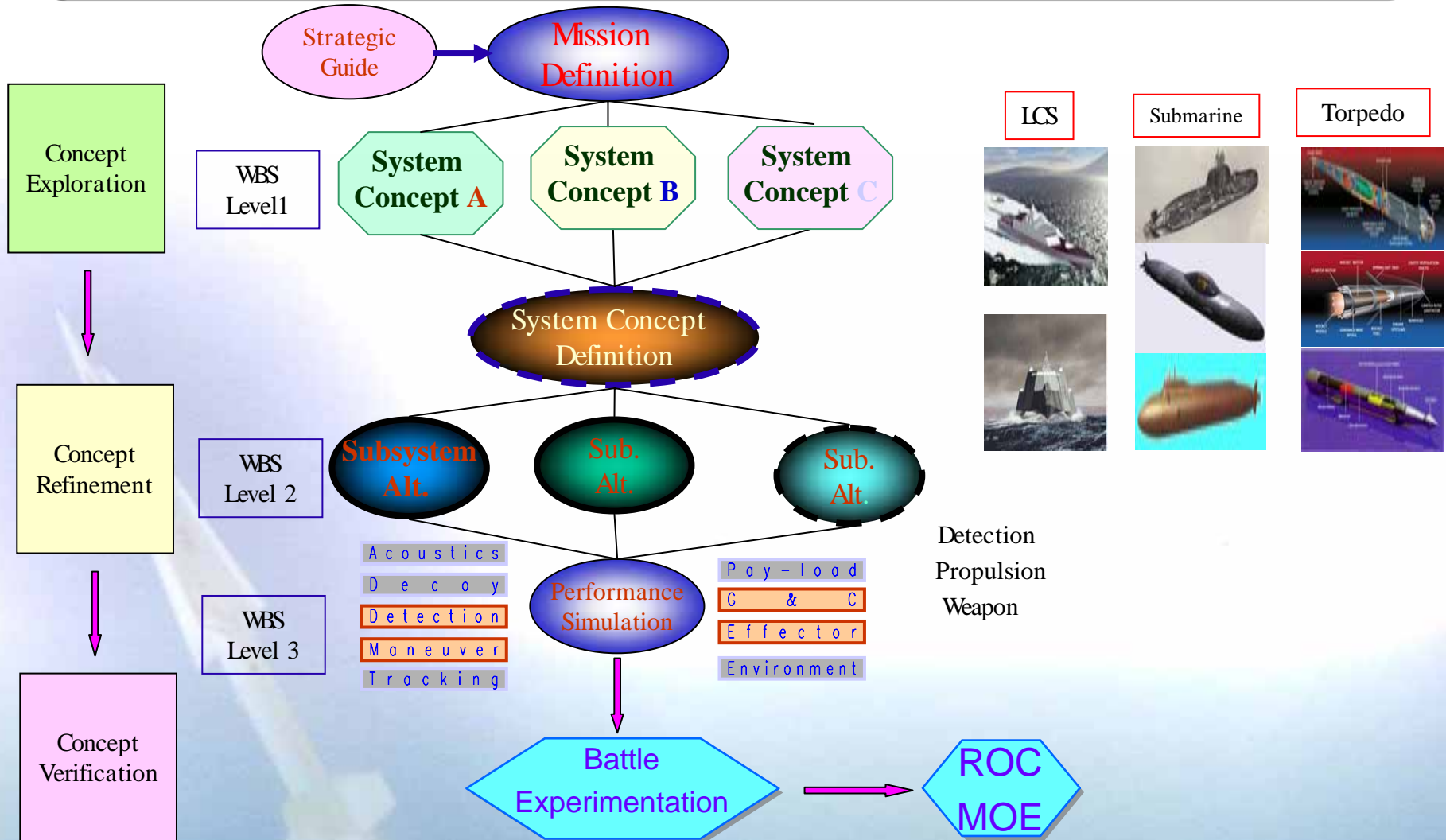
# The Role of Battle Lab. (2/3)

## ROKN New Weapon System Development Flow



# The Role of Battle Lab. (3/3)

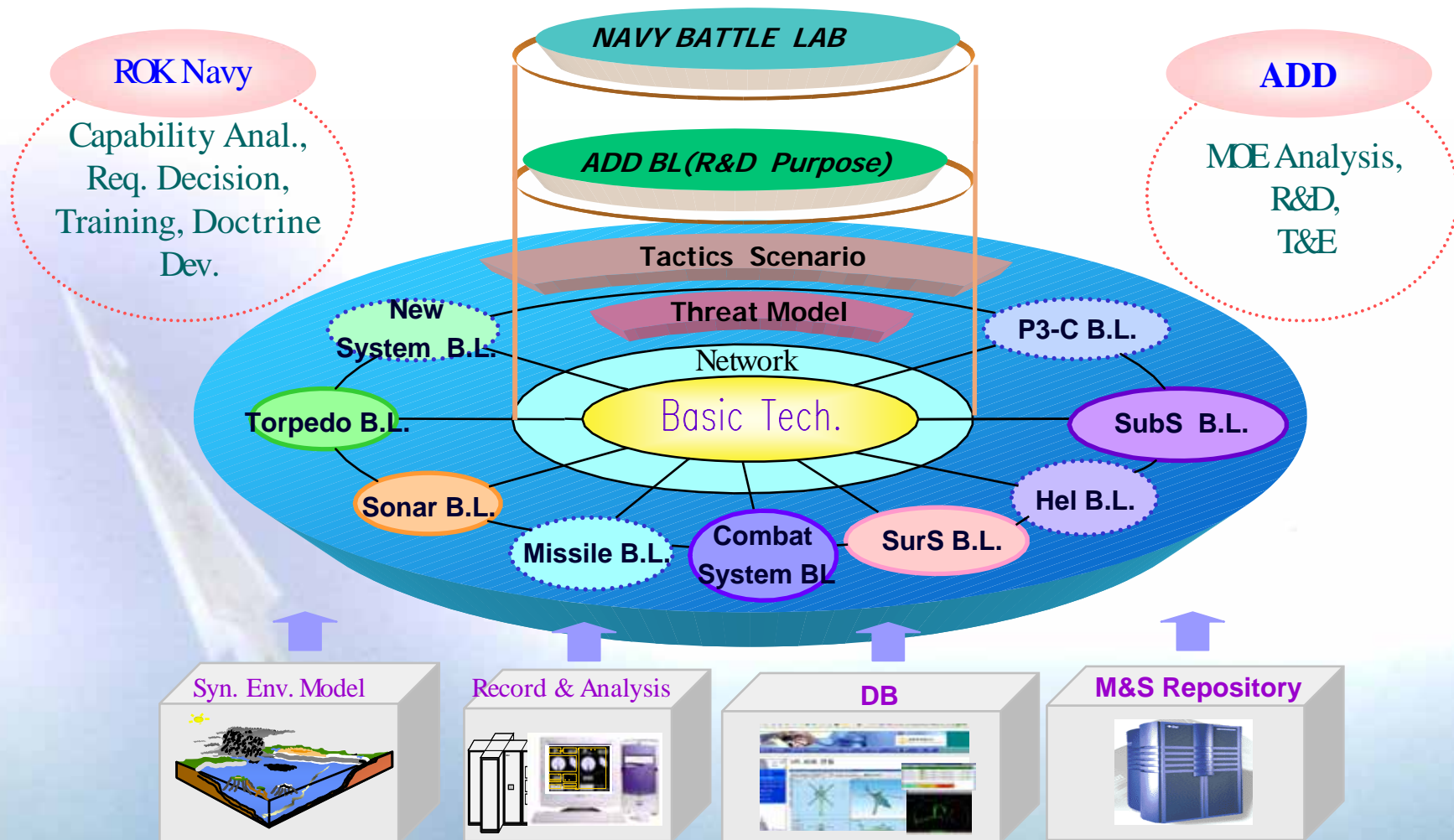
## ROK Navy: Top-down Weapon Requirement Generation





# ROKN BL and ADD BL for SBA (1/3)

## Simulator-based ADD BL and ROKN BL Building



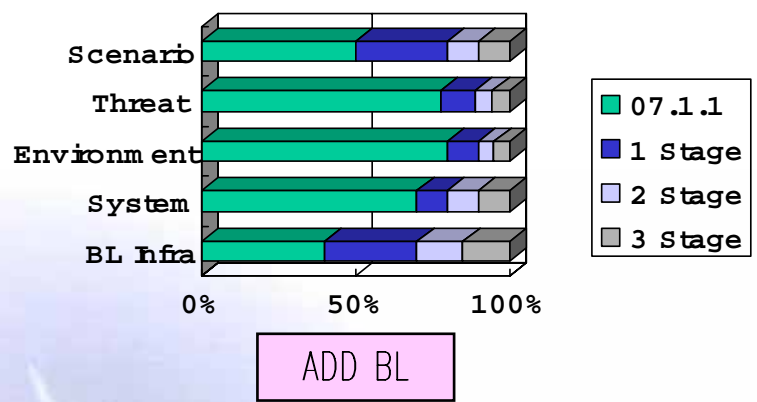
# ROKN BL and ADD BL for SBA (2/3)

## ADD Battle Lab Development Center based on LBTS

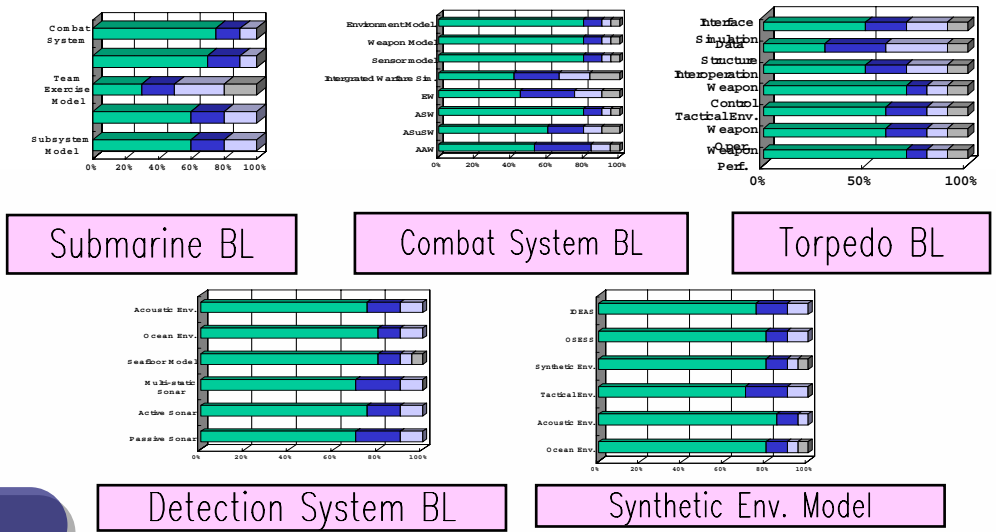


# Status and Roadmap for ROKN BL and ADD BL (3/3)

## ADD BL Status



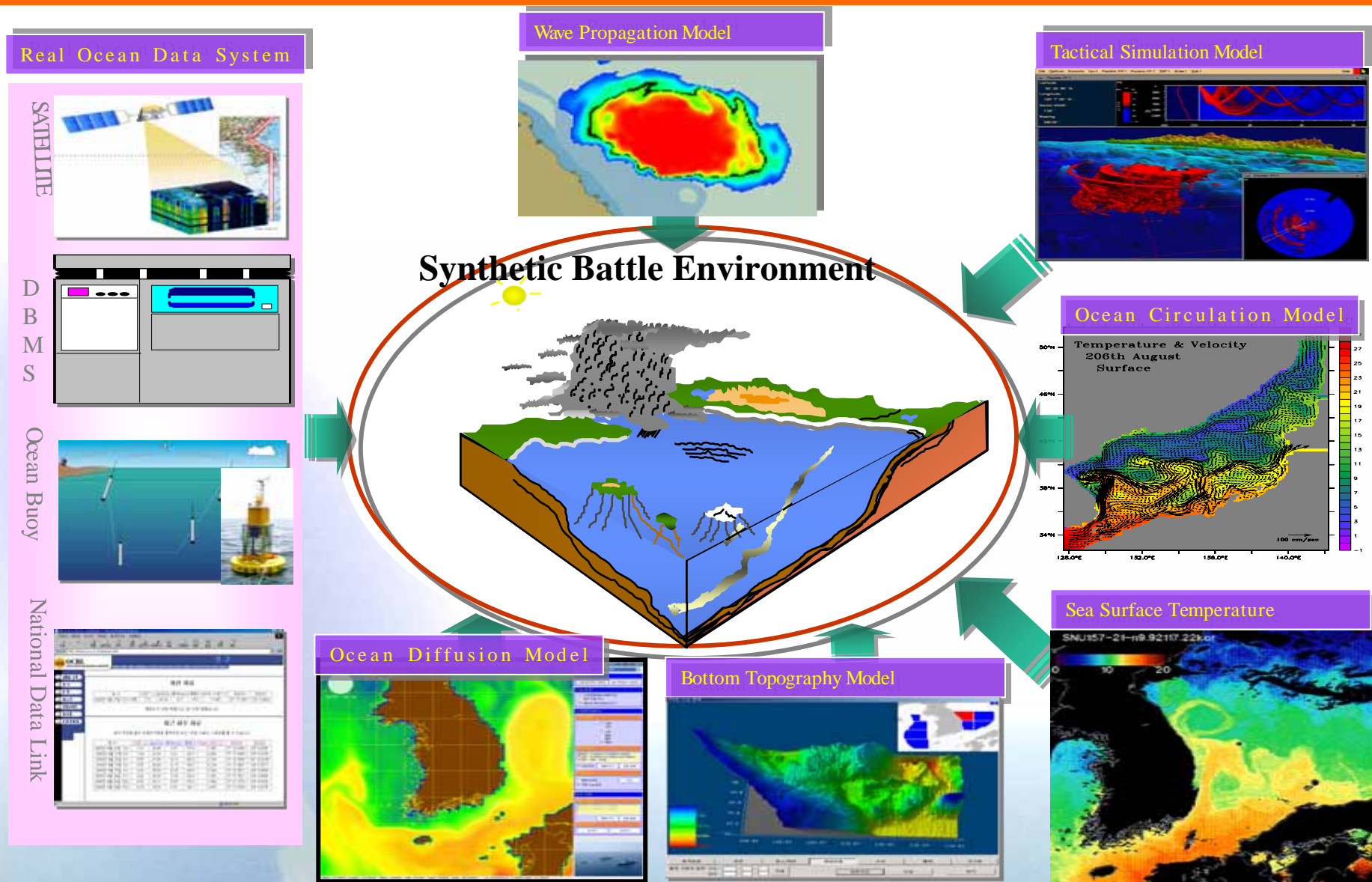
## Weapon System BL Status



## Roadmap of Battle Lab Development

Year	2006 ~ 2008		2009 ~ 2011	2012 ~ 2014
Stage	Infra Build-up		NBL BL Development	LVC based BL Development
ROKN	Mission Model	ROKN Wargame PIP		LVC based ROKN BL
	Battle Exp. for Future Program	ROKN BL Build-up		
ADD	Weapon System B.L.	Battle Lab Development Center		Battle Lab Dev. Center PIP
	ADD BL R. G.	ADD BL Development		LVC based ADD BL Build-up

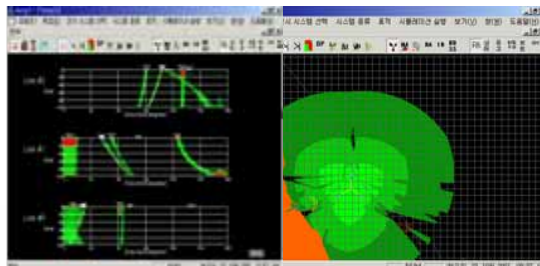
# Synthetic Battle Environment Model



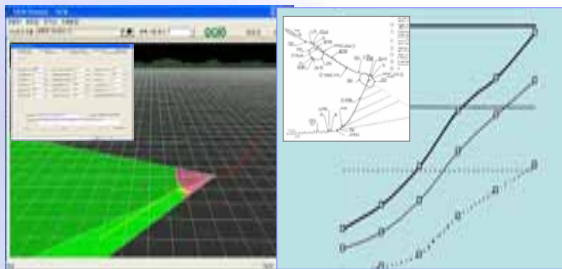


# Detection System BL

## M&S Resources for Underwater Detection System BL

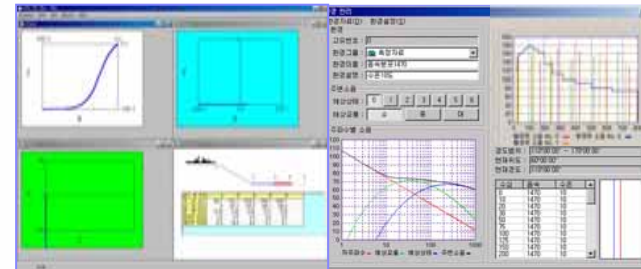


Detection Effectiveness Analysis for  
Harbor Underwater Surveillance System

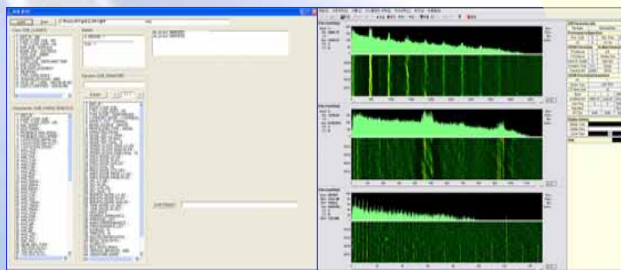


Operational Effectiveness Analysis for  
Torpedo Acoustic Countermeasure System

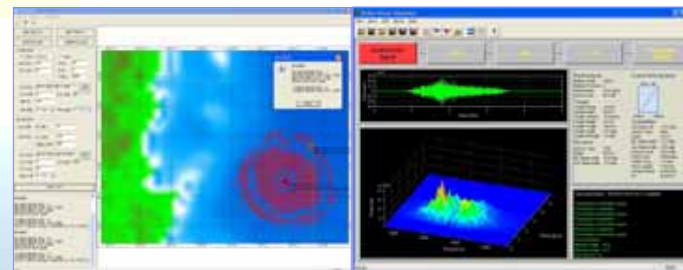
M&S Resources  
for  
DSBL-ADD



Detection Performance Analysis for  
Towed Line Array Sonar System



Signal Classification Algorithm Analysis for  
Navy Acoustic Information Management System

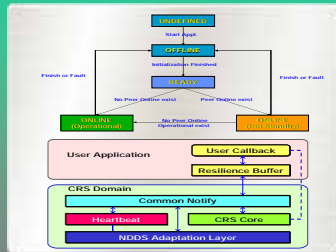


Detection Probability Estimation for  
Hull Mounted Sonar System

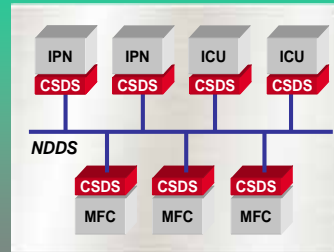
# Naval Combat System BL

## Combat System BL Status

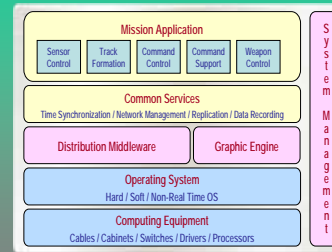
### System Monitoring/ Analysis Model



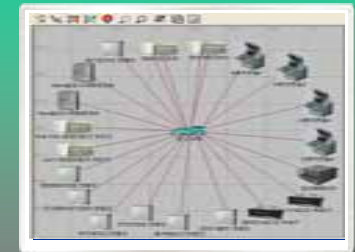
### Common Infra (Middleware) Model



### System Software Architecture Model



### Network Architecture Model

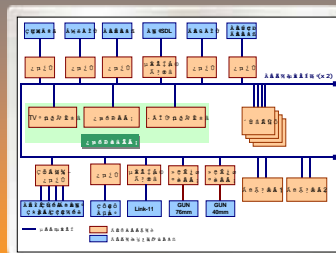


### SYSTEM INFRA STRUCTURE MODELING & ANALYSIS

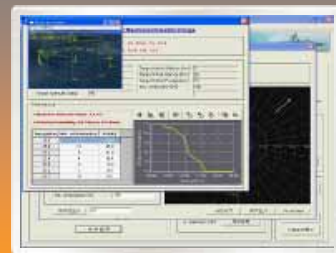
## COMBAT SYSTEM LAND BASED TEST SYSTEM (Current Project, LPX & PKX)



### SYSTEM & TACTICAL WARFARE PERFORMANCE MODELING & ANALYSIS



### System Construction Model



### Sensor System Model



### Self Defense Model



### Naval Gunfire Control Model

# 2007 US -ROK NBE Symposium

- Date: October 25-26, 2007
- Place: JINHAENAVY CLUB
- Objective of Symposium
  - Technical Information Exchange regarding Battle Lab. & Naval Battle Experimentation
  - Cooperative relation build-up between BL-related organizations of US & ROK
- Major Topics
  - Requirement Generation via Battle Experimentation for Naval Weapon Systems
  - SBA Strategy for US & ROK Naval Systems.
  - Synthetic Ocean Environment Modeling for NBE
  - Threat Modeling for Air/Surface/Undersea Warfare
  - Methodology for Fleet Battle Experimentation
  - Design and Analysis of Naval Battle Experimentation

\* NBE: Naval Battle Experimentation



# RoK/US S&T Cooperation





# Evolution of Strategic Alliance

Dependency on Conventional Forces



Combination of US and ROK technologies enabled ROK self reliant defense



Deterrence on the Korean Peninsula and within the Asian Pacific Region



Defense/Economic/democratic growth



Enabling U.S. Strategic Flexibility – 3rd largest in OIF



Direct Support

Less Soldiers/FMS

**Cooperate Self-reliant Defense**

Cooperation



# Cooperation in Defense R&D

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Some examples of mutually beneficial exchanges include:

- Engineer and Scientist Exchange Program (ESEP)
- Data Exchange Agreements (DEA)
- Project Agreements (PA)
- S&T co-development: LOGIR
- Look forward to participating in PACOM's JCTD  
: Medusa, AWSS

- \* Medusa: JCTD version of LOGIR
- \* AWSS=Airborne Weapons Surveillance System.

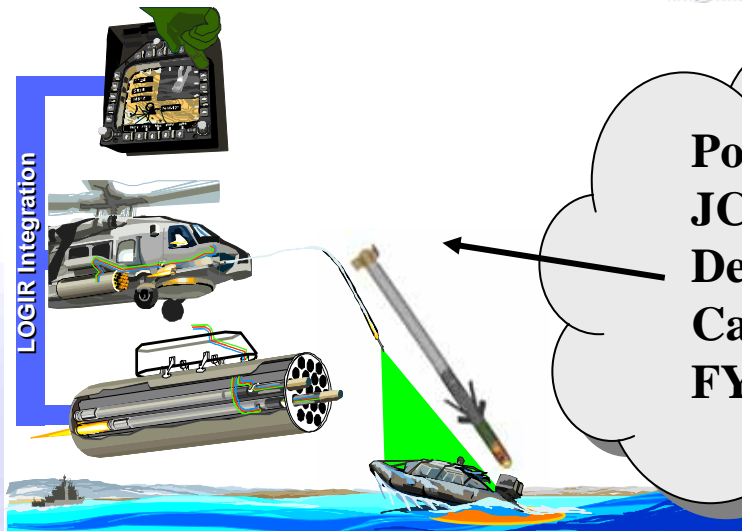
# Technology Cooperation Sub-Committee (TCSC)

An-Heung PG/Feb. 2007

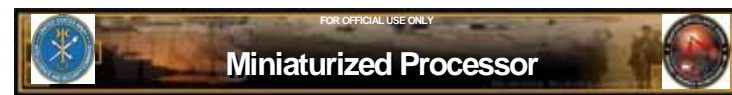


# Ongoing/Upcoming Joint Efforts

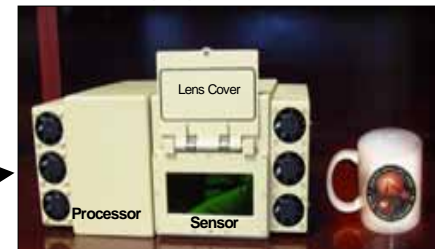
## LOGIR



Potential  
JCTD  
Developments  
Candidates for  
FY 08-10

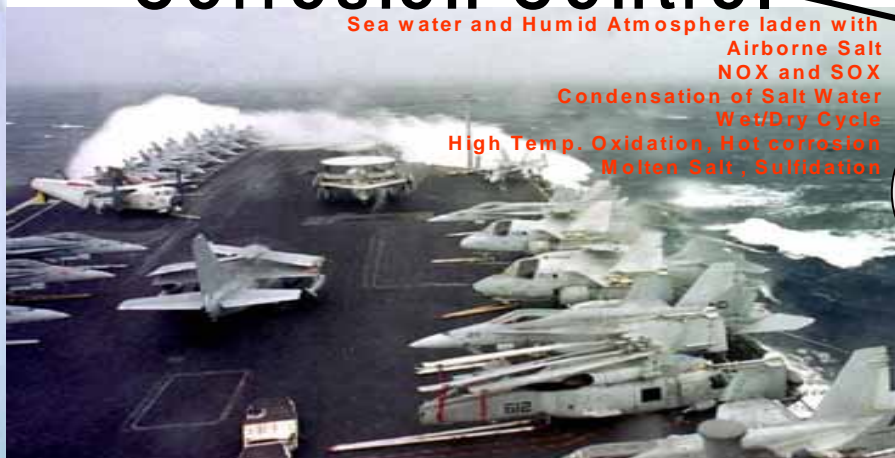


## AWSS



Form Fit & Function

## Corrosion Control



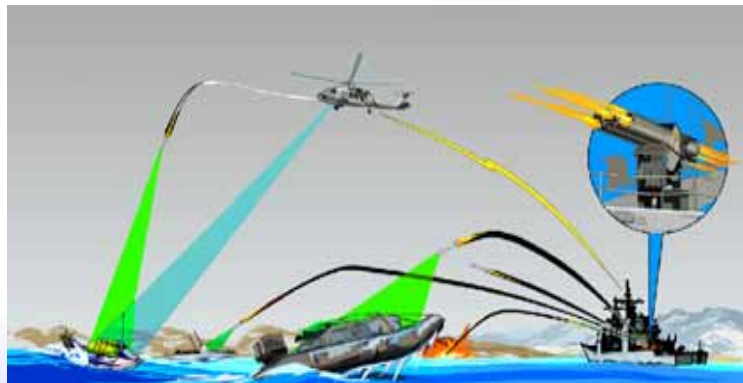
Cooperative  
Program US  
Government/  
ROK Industry  
with anticipated  
Savings to US in  
\$ Billions

FOR OFFICIAL USE ONLY

RT000401376 9



# LOGIR Collaboration



Operation Concept

## Warhead/ Fuze (Korea)

- M151 baseline (US)
- Plans improved performance given guidance section in front (Korea)

## Tail Assembly Improvements (Korea)

- MK 66 Mod 4 baseline (US)
- Plans improved aerodynamics & stability characteristics (Korea)
- *Part of an overall Korean initiative to improve performance through aerodynamic improvements to tail, seeker, and CAS*

## Control Actuation System (US/ Korea)

- LOGIR demonstration design baseline (US)
- Design to cost to maintain required performance at a reduced cost (Korea)

## Seeker/ Guidance & Control (US/ Korea)

- LOGIR demonstration design baseline (US)
- Improvements in electronic assembly design to reduce overall cost (Korea)
- Aerodynamic improvements (Korea)

# LOGIR Status

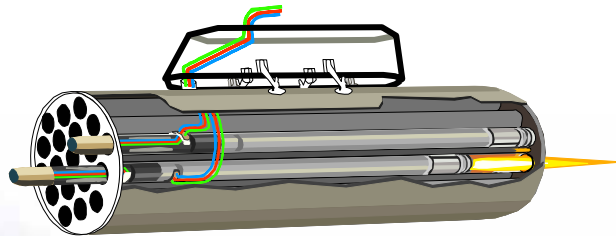
## ➡ LOGIR

- Currently S&T MOU for '07 ~ '09 between ADD and NAWC/China Lake
- To complement LOGIR technology in the areas of aero, structure, G&C, actuator, signal processing, and fuze.
- Unique Opportunities for T&E:
  - IR Data on Korea's Harsh Terrain/Weather
- Hope to continue on with SDD

## ➡ JCTD: Medusa

- April 4 workshop for details

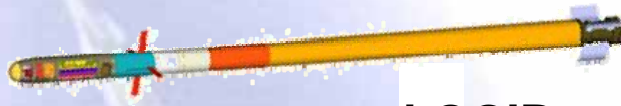
# Medusa JCTD



DRL



MH-60R



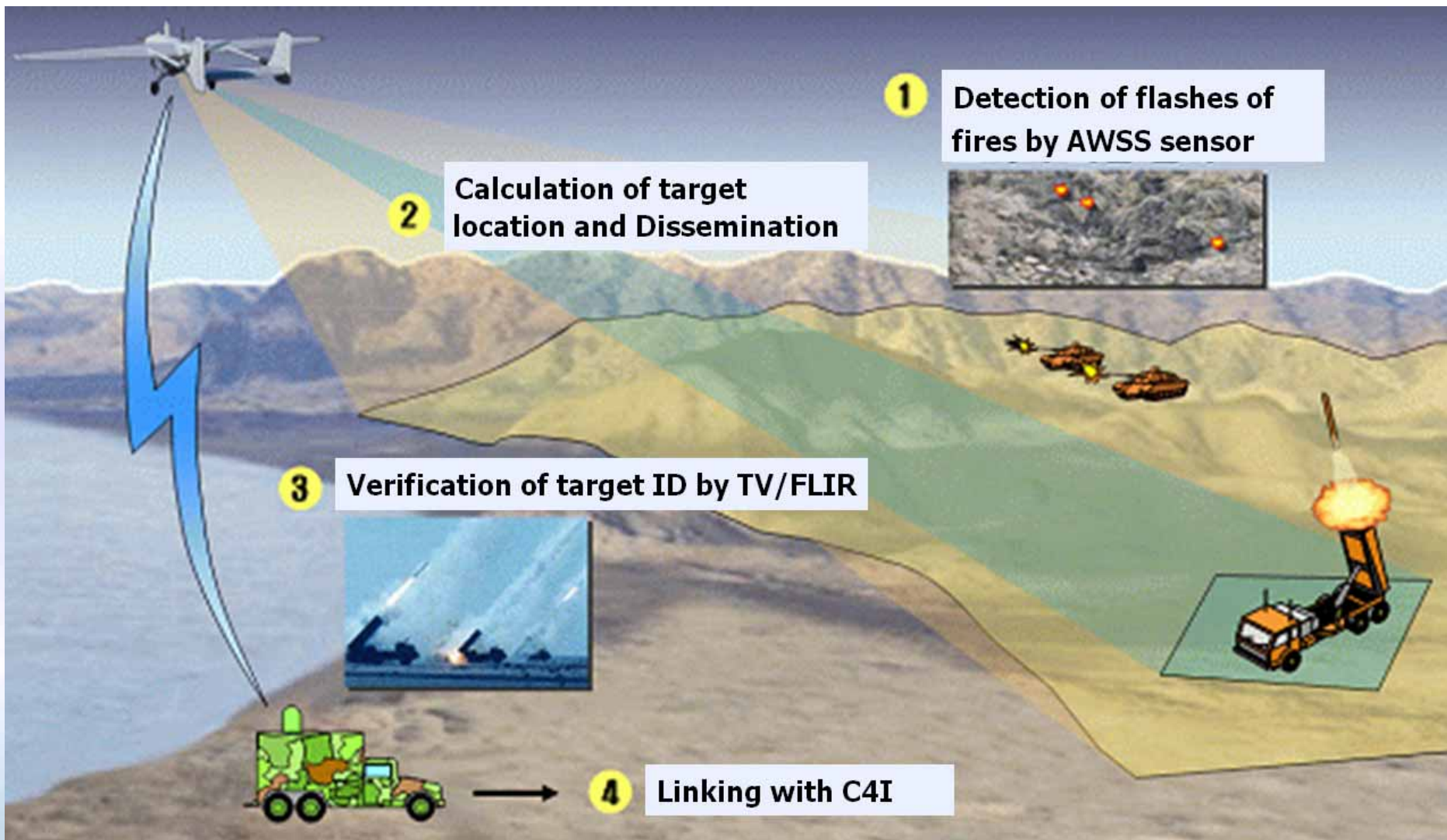
LOGIR



KO-1

- Develop core capability of LOGIR/DRL for MH-60R and KO-1 to address FAC/FIAC scenarios
- Demonstrate capability of LOGIR-enhanced platforms to engage and destroy multiple moving maritime targets

# AWSS JCTD





# Airborne Weapon Surveillance System (AWSS)

- Offers target locations and classification information in near real-time by detecting, classifying, and locating flashes from target NK fires
- To combine AWSS sensor with UAV System (Falcon)

Talks are under way between ADD and US Army.

# AWSS Components

Falcon Vehicle (Modification)



LCS (Development)



TV/FLIR



Replacement



AWSS sensor



Mini Camera

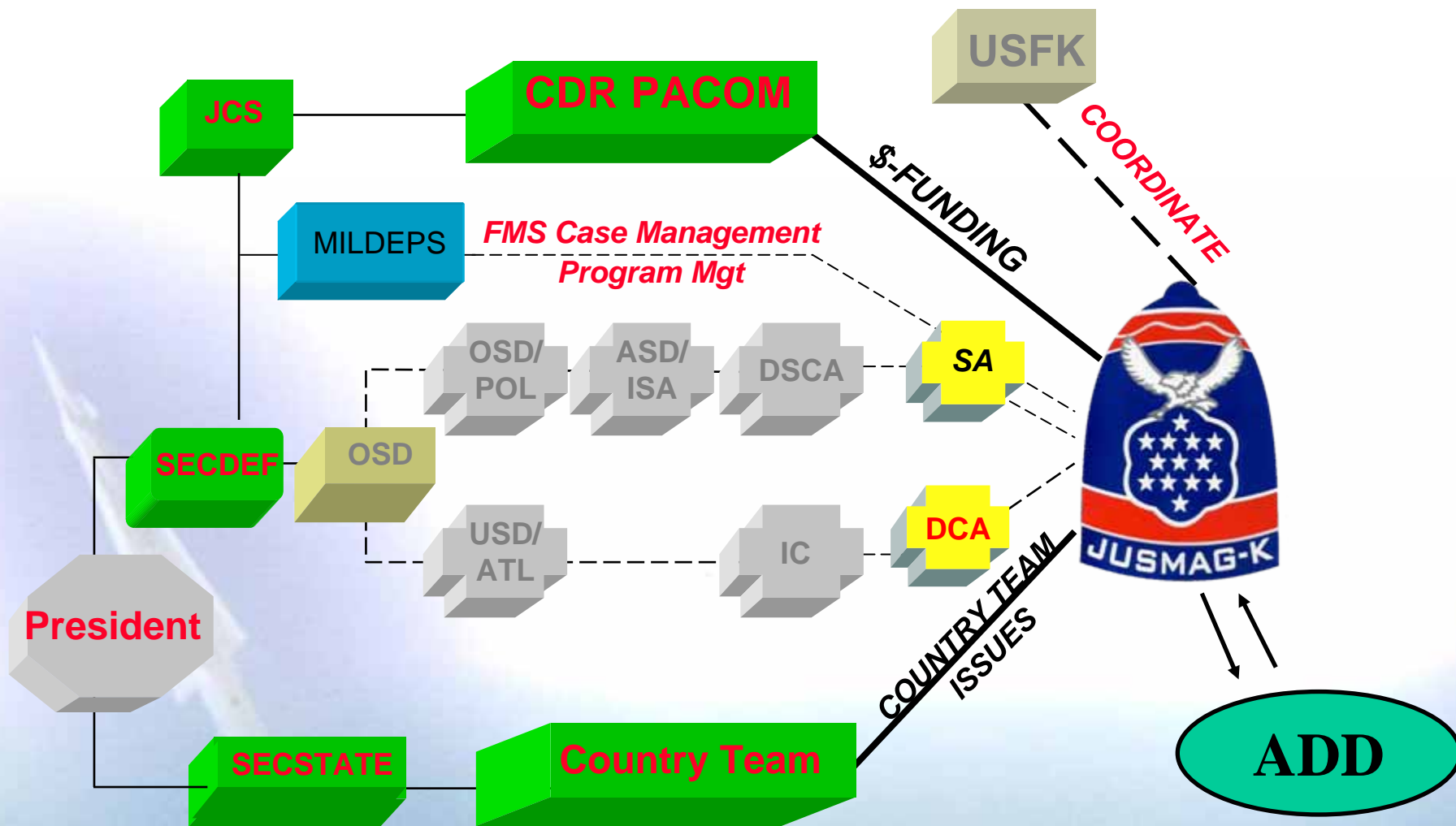
\* LCS : Launch & Recovery Control Station

# Positive Signs for Cooperation

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- ➡ Has taken a long time to come to present status
- ➡ Shift from DEA to PA, PA to Co-Development takes place
- ➡ The seeds we have sown for 50 years start to sprout

# JUSMAG-K was behind the Scenes





# Conclusions

- RoK Battle Lab program introduced
- Current cooperation status briefly reviewed  
ADD is looking for more opportunities:  
e.g. LOGIR, M&S, GPS, C3...
- International cooperation is viewed as a means of delivering capability faster and cheaper to the warfighter



# **Nuclear, Chemical and Biological Defense Research and Development**

*Pacific Operational Science & Technology  
Conference*

*4 April 2007*

***Dr. Tom Hopkins  
A/ATSD(NCB)***

# ***Outline***

- ATSD(NCB)
- Strategic Guidance
- Oversight Framework
- R&D Portfolio
- Current Capability Needs
- Emerging Threats



**Secretary of Defense**

**Under Secretary of Defense  
for  
Acquisition, Technology and Logistics**

**Assistant to the Secretary of Defense  
for Nuclear and Chemical and  
Biological  
Defense Programs**

**Counterproliferation,  
Cooperative Threat  
Reduction and Treaties**

**Chemical and Biological  
Defense and Chemical  
Demilitarization Programs**

**Nuclear Matters**

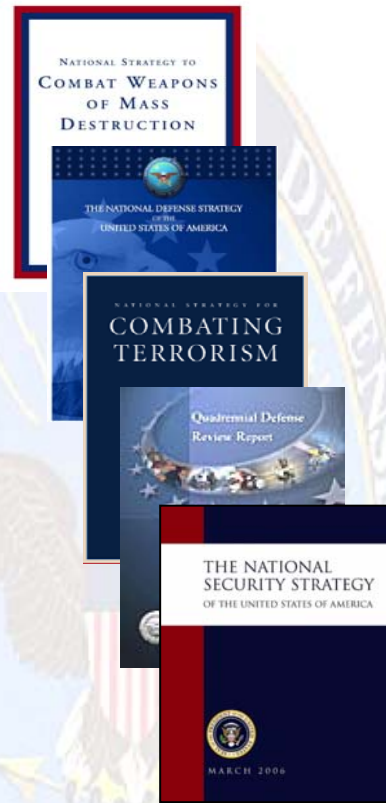
**Defense Threat Reduction  
Agency**



# ***ATSD(NCB)***

- **Principal Staff Assistant**
- **Direction and Oversight**
- **Resource Alignment**
- **Integration**
- Advise the Secretary, Deputy Secretary, and USD(AT&L) on nuclear matters and chemical and biological defense programs.
- Provide strategic direction and oversee DoD WMD threat reduction activities, combating WMD.
- Assess resource alignment with high level guidance to prevent, defeat, and protect against current and emerging WMD threats.
- Ensure research and development, multilateral cooperation, tailored threat reduction strategies and deterrence concepts are applied as integrating functions.

# ***Strategic Guidance***



- **High-level guidance includes three goals related to WMD proliferation:**
  - Prevent WMD proliferation
  - Deter, Defend and Defeat WMD use
  - Mitigate Consequences of WMD use
- **Military framework establishes eight operational missions to accomplish goals**
  - Interdiction, Cooperative Threat Reduction, Security Cooperation
  - Elimination, Offensive Operations, Active Defense
  - Passive Defense, Consequence Management
- **ATSD(NCB) focuses on DoD capabilities to achieve these goals**

# ***Oversight Framework***

- **WMD threats include potential adversaries who:**
  - Want WMD: Nonproliferation
  - Have WMD: Counterproliferation
  - Use WMD: Consequence Management
- **U.S. needs a spectrum of capabilities:**
  - *Nonproliferation to prevent WMD spread*
    - Threat reduction cooperation
    - Security cooperation and partnership activities
  - *Counterproliferation to defeat WMD*
    - Interdiction
    - Elimination
    - Active defense
    - Offensive operations
    - Passive defense
  - *Consequence Management to protect against WMD use*
    - Consequence management

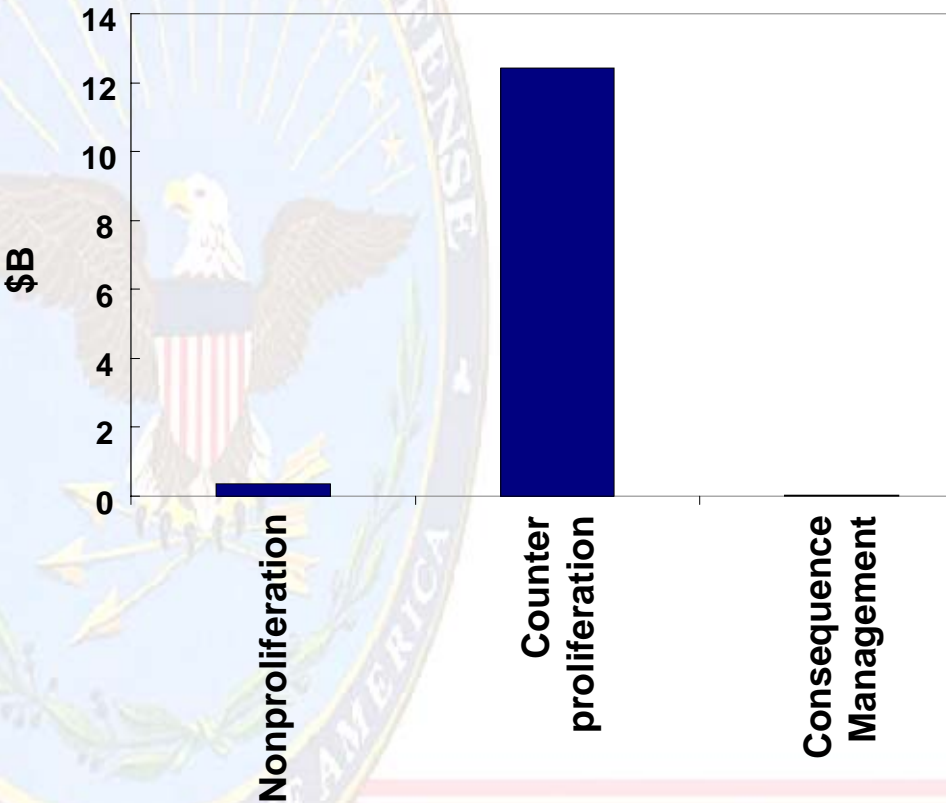
# ***R&D Portfolio***

- Correlated Combating WMD R&D programs with the three pillars and eight mission areas
- Identified mission-unique and cross-cutting technology areas
- Assessed the investment portfolio

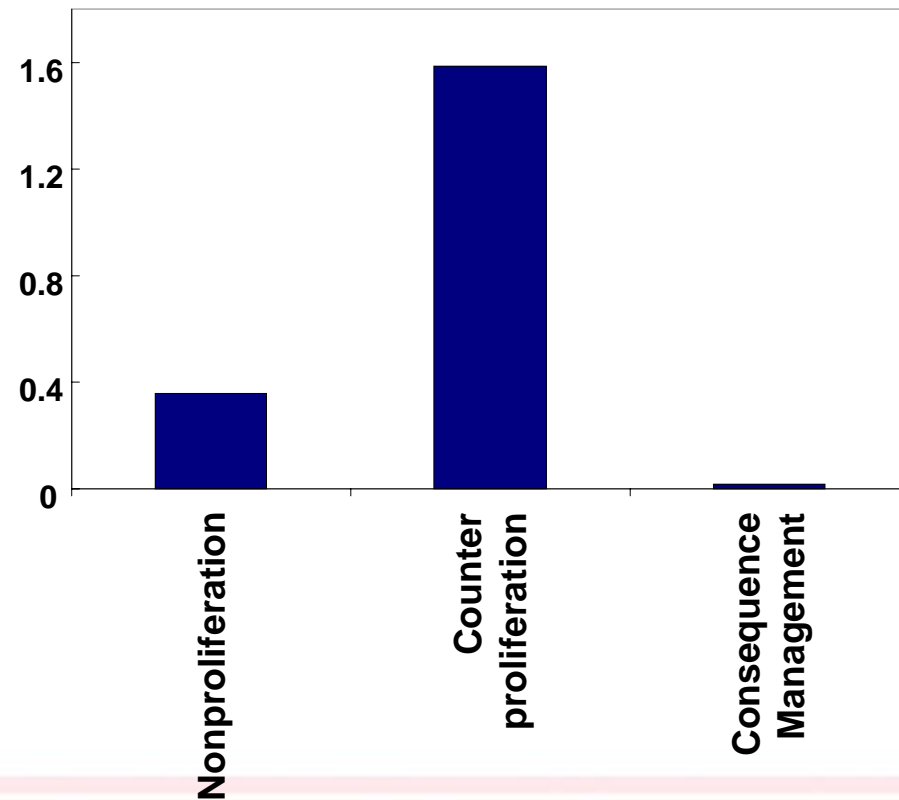


# ***FY2007 DoD R&D Investments***

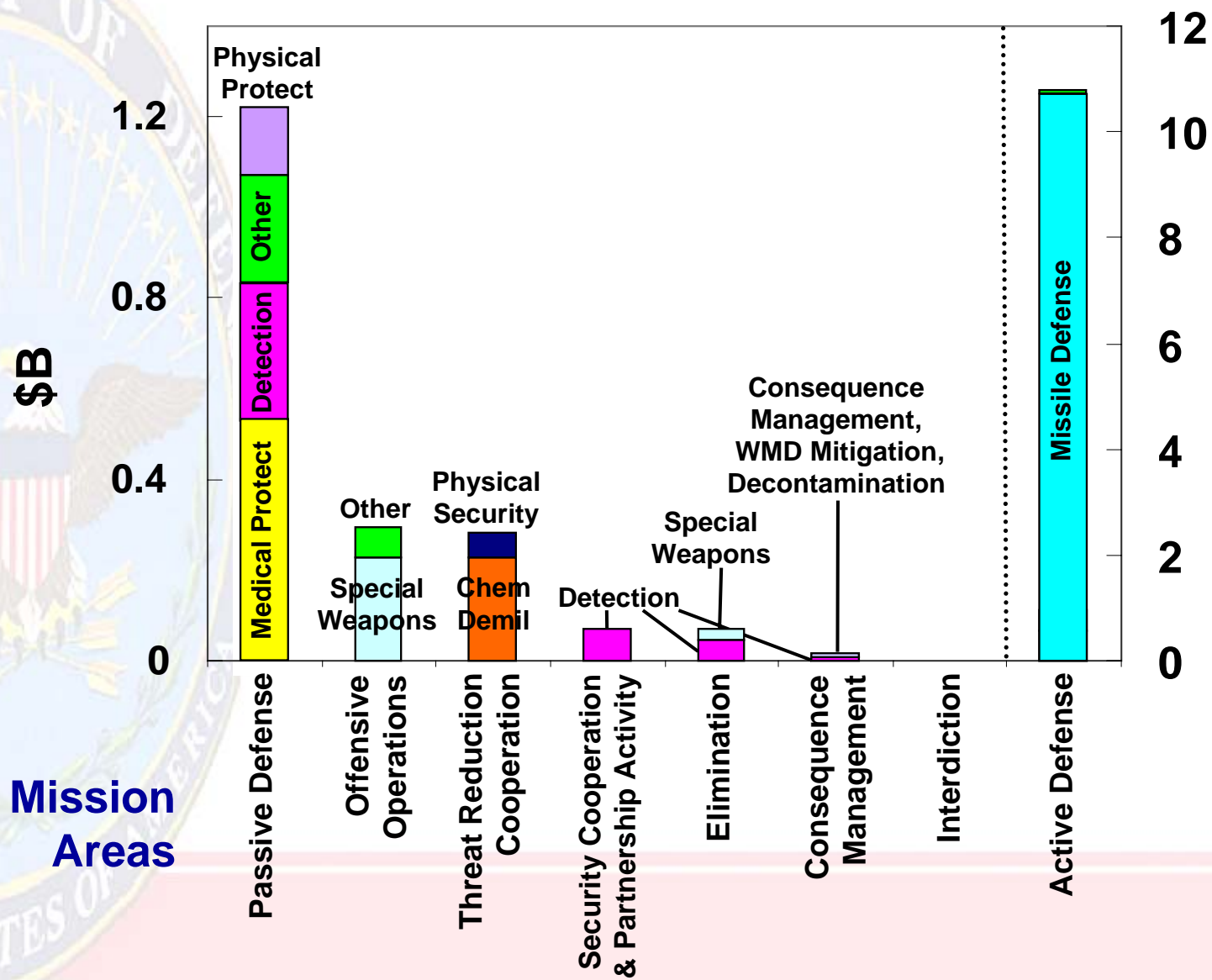
**R&D including missile defense**



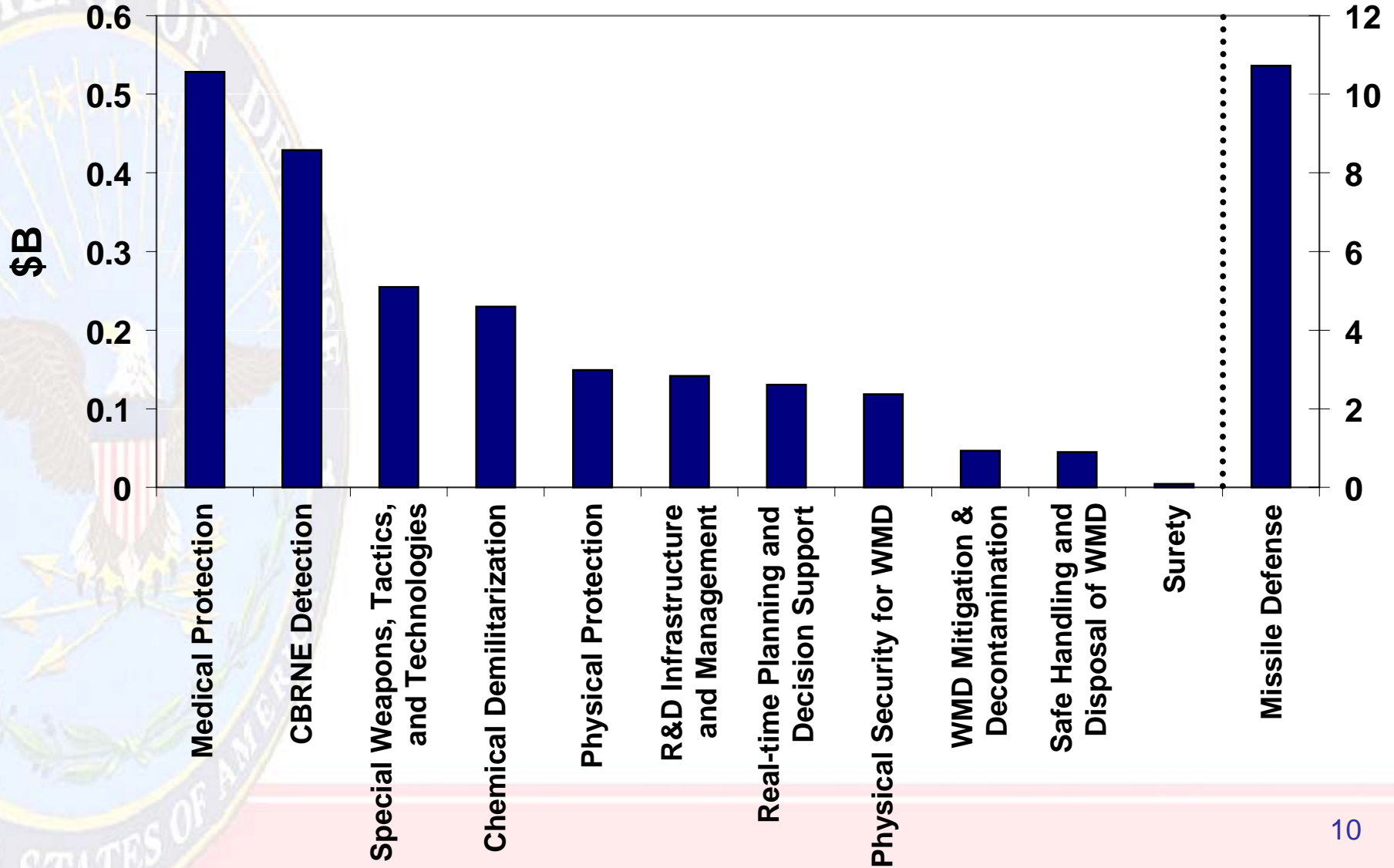
**R&D excluding missile defense**



# FY2007 DoD R&D Investments



# *Technology Areas*



# Crosscutting Technologies

## Mission Areas

### Technology Areas

	Security Cooperation	Threat Reduction Cooperation	Interdiction	Offensive Operations	Elimination	Active Defense	Passive Defense	Consequence Management
CBRNE detection	✓	✓	✓	✓	✓	✓	✓	✓
Physical methods for protection				✓			✓	✓
Medical protection							✓	✓
Specialized weapons, tactics, and technologies	✓			✓	✓	✓		
Consequence management and WMD effects mitigation/decontamination		✓		✓	✓	✓	✓	✓
Real-time planning and decision support			✓	✓	✓	✓	✓	✓
Physical security for WMDs	✓	✓	✓	✓	✓	✓		✓
RDA infrastructure and management	✓	✓	✓	✓	✓	✓	✓	✓
International cooperation activities and WMD demilitarization	✓	✓						✓
Safely handle and dispose of WMD (and explosives)		✓	✓	✓	✓			✓
Tailored Strategies	✓	✓	✓	✓	✓	✓	✓	✓

**All technology areas support more than one mission**



# ***Portfolio Summary***

- **Nonproliferation**

- Predominantly domestic Chemical Demilitarization
- Focused on detection for arms control applications, arms control information technology, and nuclear physical security

- **Counterproliferation**

- Active defense investments are largest, dominated by missile defense
- Focused on physical protection, offensive operations medical countermeasures, decontamination, and detection

- **Consequence Management**

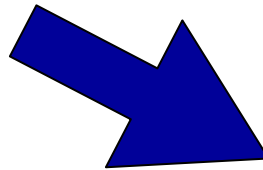
- Focused on technical reachback, nuclear forensics and technologies for civil support teams

# R&D Addresses Command Needs

## Portfolio Summary

- **Nonproliferation**
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- **Counterproliferation**
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  - Focused on physical protection, medical countermeasures, decontamination, and detection
- **Consequence Management**
  - Focused on technical reachback, nuclear forensics and to test technologies for civil support teams

12



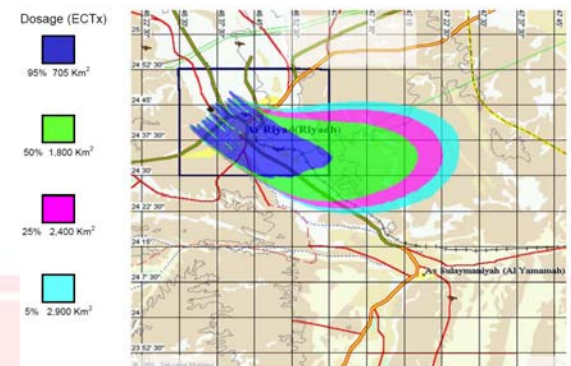
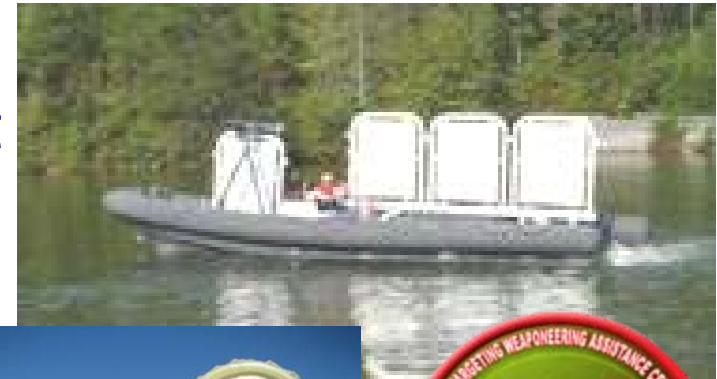
## Command Priorities

- Persistent surveillance
- Adversarial intent
- Missile defense
- Overcoming integrated air defense systems
- Fast transportation and fast ships
- International military education and training
- Foreign consequence management
- Preferred munitions
- Prompt, hard target defeat capability
- Pandemic preparation

# Current Capability Needs

## Detection, Identification, and Characterization of CBRN Threats

- Detect WMD at operationally relevant distances
- Track WMD and related materials
- Real-time reachback for technical support for detect, identify and characterize
- Application to targeting, weaponeering, bomb damage assessment, treaty compliance, border security, decontamination, demilitarization, force protection, and other operational applications

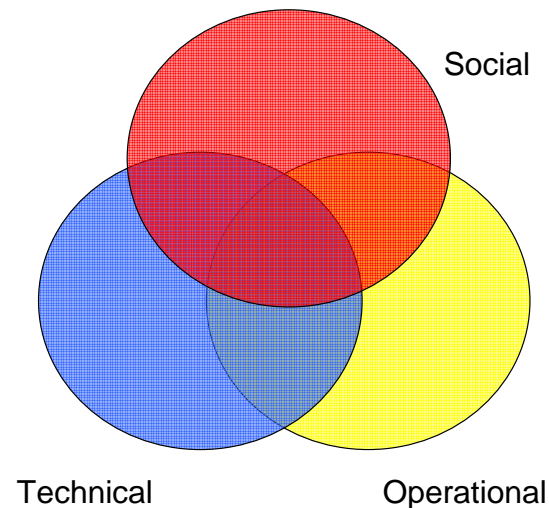


# Current Capability Needs

## Decision Support and Planning

- Indicators and understanding of adversarial intent
- Rapid processing of intelligence and dissemination to appropriate decision points allowing rapid action
- Information exploitation

Proliferation Pathway Dimensions



**JTAC**

the joint threat  
anticipation center



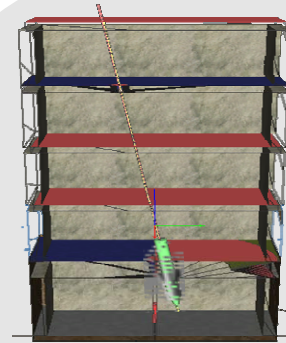
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# Current Capability Needs

## Offensive Operations

- Defeat WMD targets
  - Hard and deeply buried targets
    - Tunnels
    - Bunkers
  - Agent defeat technologies
- Secure, neutralize, store, and destroy or dispose of WMD



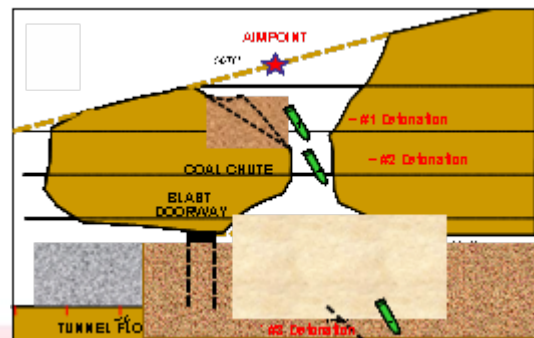
Deep Bunker Targets



Tunnel Targets



Tunnel defeat tests



Hard Target Defeat



Tunnel Tests

# ***Current Capability Needs Protection***

- Medical countermeasures
  - Vaccines and broad spectrum therapies
  - Medical prophylaxis
- Medical response, especially active syndromic surveillance coupled to mass treatment and quarantine
  - Bio-surveillance capabilities
- People, facilities, and mission protection

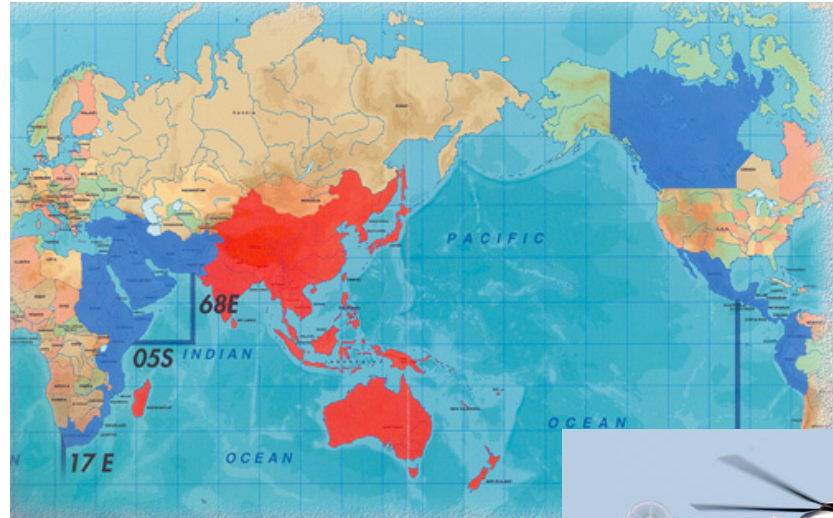




# ***Current Capability Needs***

## ***Security Cooperation***

- Interagency and international data exchange, coordination, and training
- New partnerships, agreements, and initiatives



# *Observations*

- CBRN detection investment is significant
  - Challenges: Stand-off detection, identification and characterization
- Decision support tools are embedded in larger systems
  - Challenges: Real-time situational awareness and threat anticipation
- Offensive operations R&D investments are dominated by hard and deeply buried target and agent defeat
- Protection is single largest technology area
  - Medical protection dominates and remains the biggest challenge
- Security cooperation R&D...future requirements?



# ***Emerging Threats***



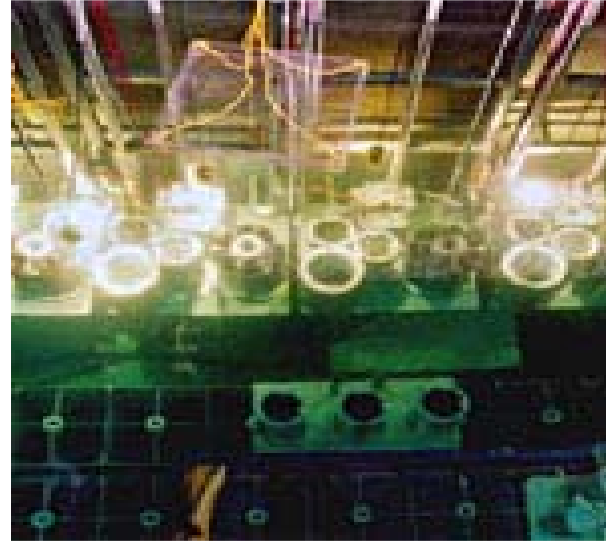
# ***Emerging Threats***

- **Nuclear Proliferation**

- New nuclear weapons states
- Acquisition of nuclear weapons by non-state or sub-state actors

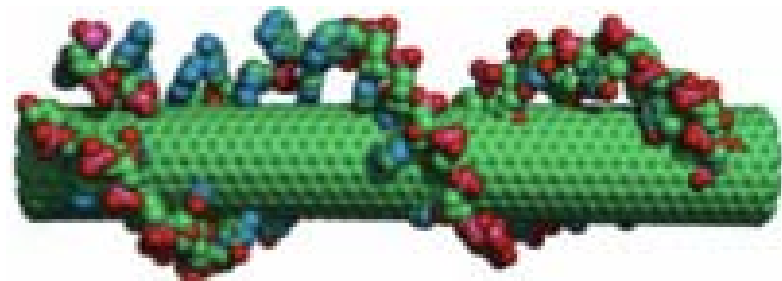
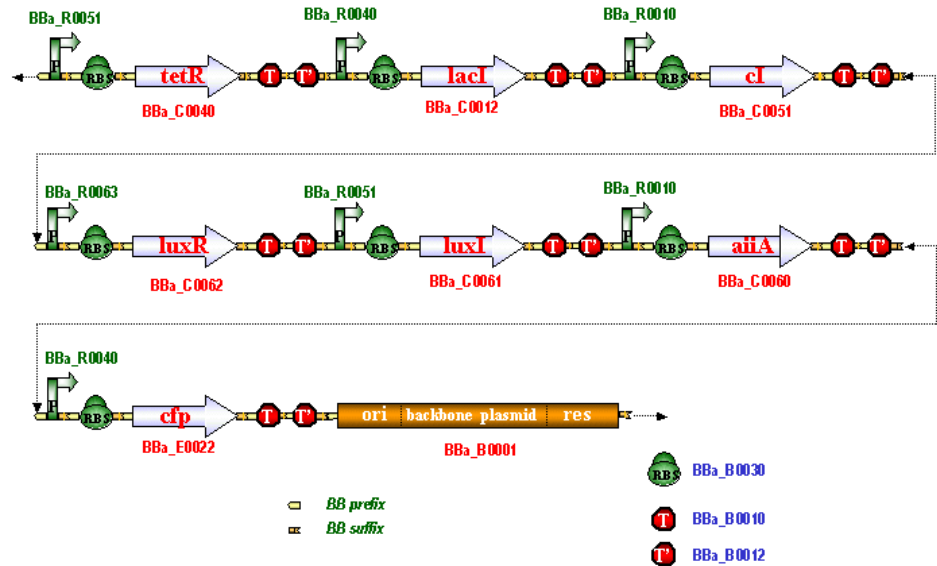
- **Natural Pandemics**

- Global connectivity and modern transportation are accelerating vectors for transmission
- Security and social aspects
- Emerging public health threats can also become BW threats



# Emerging Threats

- **Biotechnology**
  - Dual-use technology
  - Genetic engineering
  - Synthetic biology
- **Nanotechnology**
  - Nano-enabled biochemical agents and energetic materials
  - Circumventing vaccines and evasion of medical countermeasures
  - Anti-material agents



# ***Emerging Responses***

Responses to emerging threats will require the full spectrum of R&D, operational, intelligence, political measures and international partnerships



# ***ATSD(NCB) Challenges***

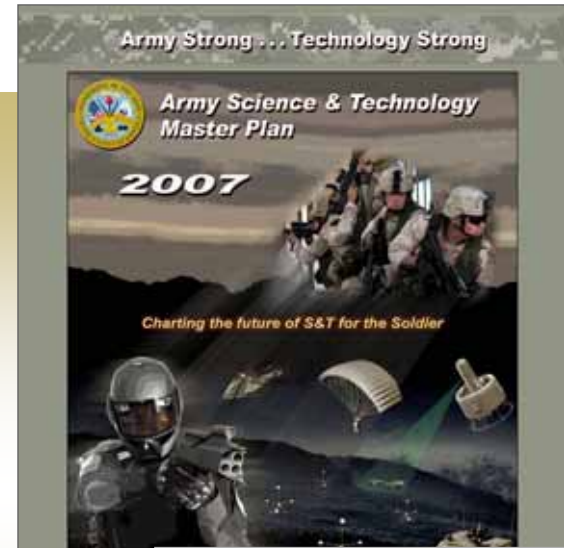
- Assess and improve the Combating WMD R&D investment strategy
  - Guidance
  - Current needs
  - Emerging threats
- Ensure that R&D communities communicate and collaborate with stakeholders



# *Army Science & Technology Overview*



*4 Apr 2007*



*Dr. Thomas H. Killion  
Deputy Assistant Secretary  
for Research and Technology/  
Chief Scientist*



# ***Outline***

---

- ***Science and Technology (S&T) Strategy***
- ***Warfighter Guidance and Drivers***
- ***Technology Area Investments***



# Science & Technology for a Campaign Quality Army with Joint & Expeditionary Capabilities

## Current Force



~100 lb. load



Limited network



> 70 tons



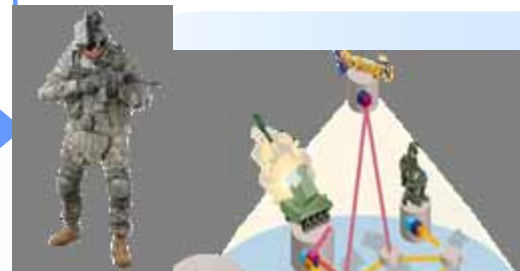
< 10 mph

## Enabling the Future Force

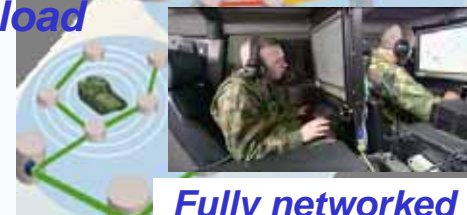
Science and Technology—  
develop and mature  
technology to enable  
transformational  
capabilities for the  
Future Force while seeking  
opportunities to accelerate  
technology directly into  
the Current Force

## Enhancing the Current Force

## Future Force



< 40 lb. load



Fully networked



< 30 tons



> 40 mph





# From Science to Technologies...Systems

## 3 Different Types of S&T Investments

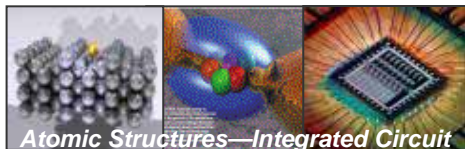
**S&T  
PB08  
\$1.7B**

**Development**

**Acquisition**

### 6.1: Basic Research 18% of S&T

#### Nanoscience



- Understanding to solve Army-unique problems
- Knowledge for an uncertain future

### 6.2: Applied Research 40% of S&T

#### Integrated Textile Conductors

Embedded Input Device



- Applications research for specific military problems
- Components, subsystems, models, new concepts

### 6.3: Advanced Technology Development 42% of S&T

Precision  
Air Drop—  
50 meters



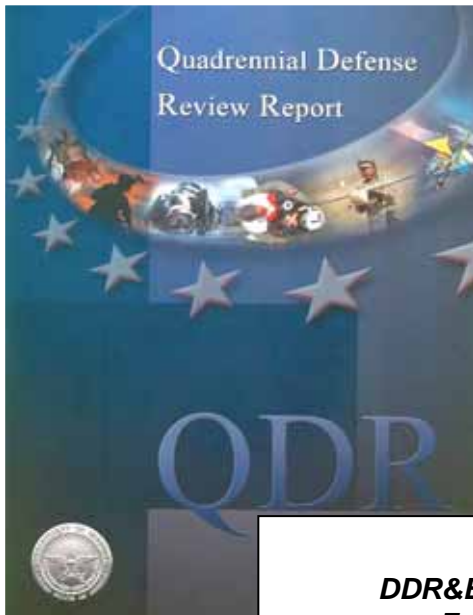
- Demonstrate technical feasibility at system and subsystem level
- Assess military utility
- Path for technology spirals to acquisition—rapid insertion of new technology

**Far Term**

**Mid Term**

**Near Term**

# OSD Planning Framework



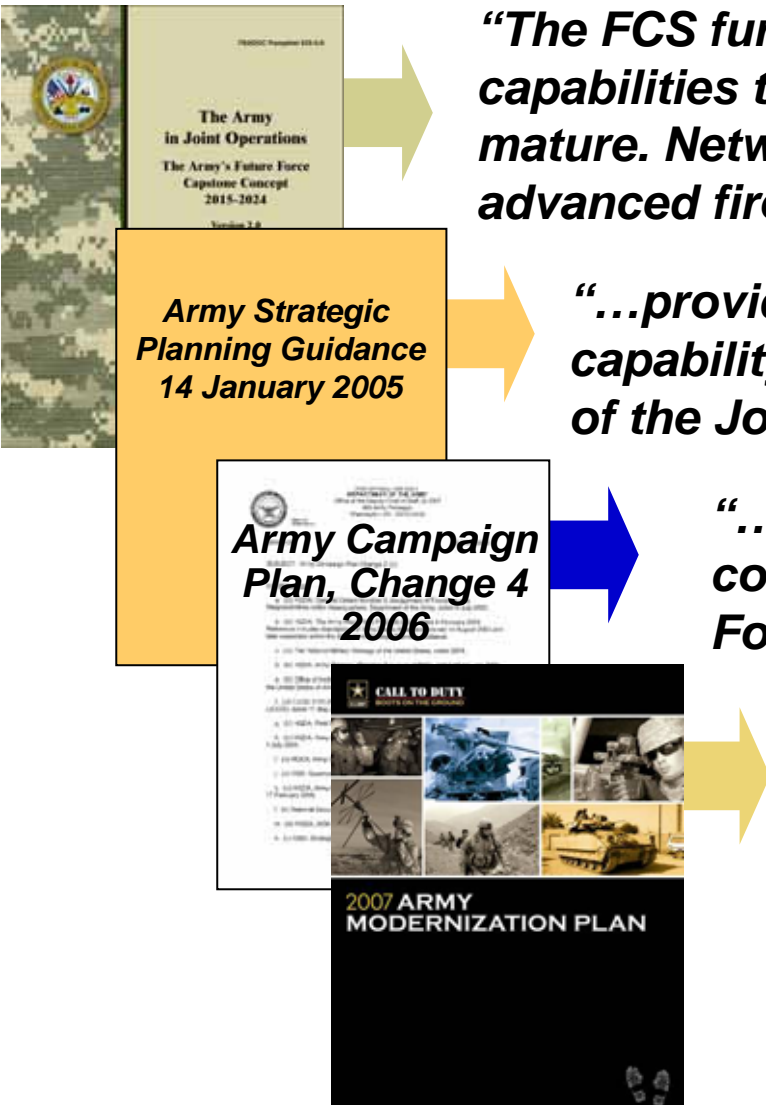
***Enhance our expeditionary combat power and shape the Services to be lighter, yet more lethal, more sustainable and more agile***

***DDR&E Guidance  
Feb 2006***



***Protection, Battlespace Awareness, Force Application, Focused Logistics—implementing QDR guidance***

# Army Level Guidance



The diagram illustrates the progression of Army Level Guidance through four key documents, connected by arrows. The documents are: 1. 'The Army in Joint Operations: The Army's Future Force Capstone Concept 2015-2024' (top left), 2. 'Army Strategic Planning Guidance 14 January 2005' (middle left, orange box), 3. 'Army Campaign Plan, Change 4 2006' (bottom left, white box), and 4. '2007 ARMY MODERNIZATION PLAN' (bottom left, black box). Arrows point from the first document to the second, from the second to the third, and from the third to the fourth. A large yellow arrow also points from the first document to the first quote on the right. A blue arrow points from the third document to the second quote on the right. A yellow arrow points from the fourth document to the third quote on the right.

***“The FCS further encompasses a set of technologies and capabilities that will spiral into the entire Army as they mature. Networked C4ISR, precision munitions, and advanced fire control will also be key enablers.”***

***“...provide relevant and ready land power capability to the Combatant Commander as part of the Joint Team”***

***“... provide relevant and ready land power to combatant commanders and the Joint Force...”***

***"The Army's investment strategy pursues technologies to achieve the goal to field forces that are "lighter yet more lethal, more sustainable and more agile" while achieving entirely new capabilities..."***



# TRADOC Capability Gaps— Shaping S&T Programs



## **Emerging Top Challenges for Current Force 2006**



- *Networked Enabled Battle Command*
- *Protect Force in Counterinsurgency Operations*
- *Soldier Protection in Counterinsurgency Environment*
- *Logistics and Medical in Counterinsurgency Operations in non contiguous battlespace*
- *Train the Force How and As it Fights*
- *Tactical Communications*
- *Ability to Conduct Joint Urban Operations*
- *Joint Interoperability, Coalition and Interagency Operations*
- *Enhanced ISR Capabilities*
- *Timeliness of Analysis, and Information Dissemination*



## **Future Force Capability Gap Areas**



- *Enhanced Soldier Protection*
- *Modular, Scalable and Tailorable Battle Command and Control*
- *Enhance Platform/Group Protection*
- *Dynamic, Uninterrupted Communications Network*
- *Sustainment of Modular Forces*
- *Enhanced Collection, Exploitation and Dissemination*
- *Strategic Force Projection/Intratheater Operational Maneuver and Sustainment*
- *Modular, Tailorable Forces*
- *Capability for Lethal/Non-lethal Overmatch*
- *Ability to Train the Force How and As it Fights*





# Responding to Joint Needs



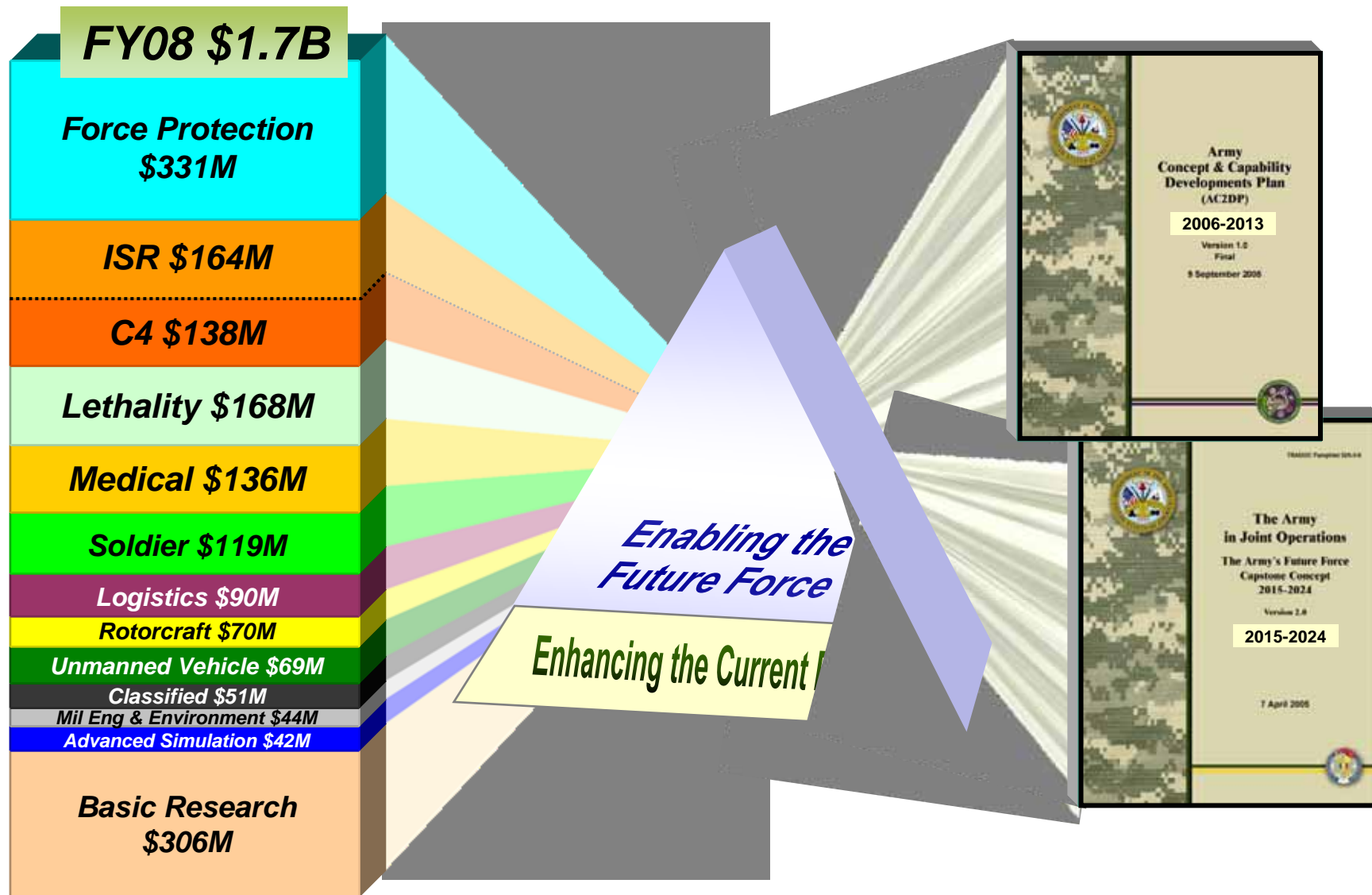
Integrated Priority List

Integrated Priority List

Integrated Priority List

...

# Technology Area Investments to Satisfy Gaps—New Capabilities





# FCS Brigade Combat Team



## Manned Ground Vehicles (MGV)

Infantry Carrier Vehicle (ICV)

Command and Control Vehicle (C2V)

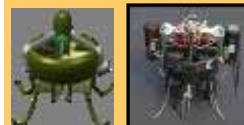
Mounted Combat



## Unmanned Aerial Systems (UAS)

Class I UAV

Class IV UAV



Reconnaissance And Surveillance Vehicle (RSV)



## Unattended Ground Systems (UGS)

T-UGS

U-UGS



Tactical and Urban Unattended Ground Sensors



Non-Line of Sight Launch System (NLOS-LS)

Common Chassis

Advanced Lightweight Armor

Engine



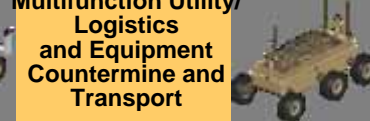
Non-Line of Sight Mortar (NLOS-M)



## Unmanned Ground Vehicles (UGV)

MULE 2

Multifunction Utility/Logistics and Equipment Countermine and Transport



Armed Robotic Vehicle – Assault (Light) (ARV-A-L)



Small UGV (SUGV)



Medical Vehicle Treatment (MV-E)



FCS Recovery and Maintenance Vehicle (FRMV)







# Support to Current Operations

## Demonstrations, Prototypes, or Limited Fieldings

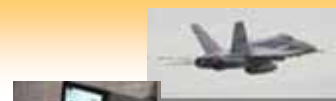
### Countermine/ Counter Boobytrap



WARLOCK Jammers



Explosive  
Detection



Change Detection  
Workstation

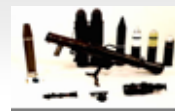
### Enhanced Lethality



Acoustic  
Gunfire  
Detection  
System



SWORDS

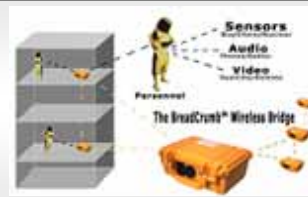


Special  
Purpose  
Munitions

### Network



Well  
Camera



Secure  
Wireless  
Relays



Satellite  
Nodes

### Power & Energy



Zinc-Air  
Battery  
Family



"AA"  
Battery  
Solar  
Charger



SATCOM &  
Javelin Hybrid  
Power Sources

### Survivability



Integrated  
Rocket, Artillery,  
Mortar (RAM)  
Detection



Backstop





# Current Force—Force Protection

## Platform Protection



**Stryker w/Bar Armor**



**Tactical Vehicle Add-on Armor**



**Deltoid Axillary Protection**



**Vehicle Class Body Armor Support System**



**Expedient HMMWV Armor Kit**



**Tear-off Windshields**



**SAPI Plates**



**Interceptor Body Armor**

## Counter Rocket Artillery Mortar



**Unattended Transient Acoustic MASINT System (UTAMS)**



**Backstop**



**Lightweight Counter Mortar Radar**

## Countermines/Counter Boobytrap

**Detection, Surveillance, Neutralization and Defeat**



**Airborne Detection**



**Neutralization**



**Robotic Detection/Neutralization**



# Future Force—Force Protection

## Platform Protection



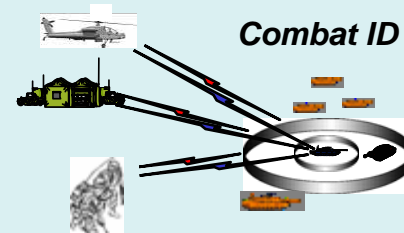
**Structural Armor**



**Active Protection**



**Laser Vision Protection**



**Combat ID**



**Integrated Rotorcraft Protection**

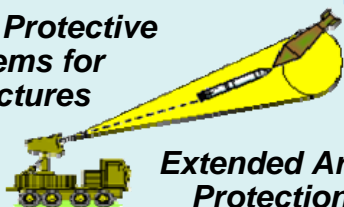
## Counter Rocket Artillery Mortar



**Modular Protective Systems for structures**



**Solid State Laser (SSL) Weapon System Concept**



**Extended Area Protection**

## Countermine/Counter Boobytrap

**Detection, Surveillance, Neutralization and Defeat**

**Networked Electronic Warfare**



**Packbot w/ sensor**



**Concealed Explosives Detection**



# Current Force—ISR and C4

## Command & Control



**Urban Tactical Planner (UTP)**



**Agile Commander**

## Networked Comms



**Airborne Network Extension**



**Tele-engineering**



**Extended Range Communications (Breadcrumb)**



**Integrated Meteorological System**

## Surveillance & Sensors



**Overwatch—Detection & Classification of Hostile Fire**

### Well Camera & Remote Robotic Vehicle



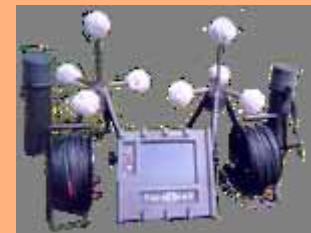
**Mobile Stabilized Panoramic Sight**



**IR Sensors for Small Raven & Pointer**



**Wide Field of View Night Vision Goggle**



**Pilar Gunfire Detection System**

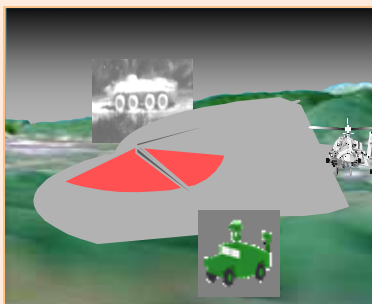




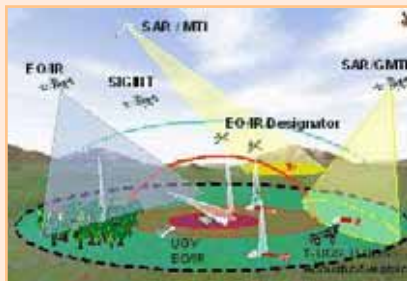
# Future Force—ISR and C4

ISR  
C4

## Persistent Sensor Coverage



3<sup>rd</sup> Gen Infrared Sensors



Layered Networked Sensors

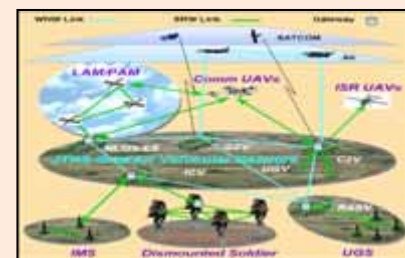
## Command & Control

### Knowledge Fusion



Flexible Displays

## Tactical Mobile Networks

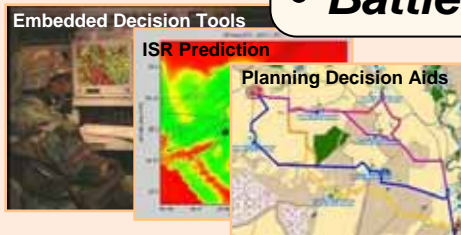


## MOUT/Situational Awareness



Through Wall Sensing

Pos/Nav Network Assisted  
and Improved MEMS IMUs

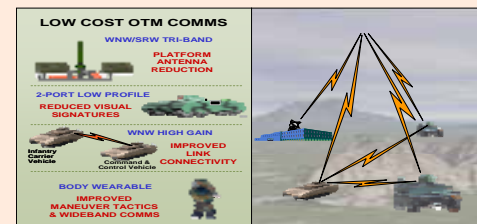


C2 in Urban Terrain



- Find the Enemy
- Assured Comms
- Battle Command

## Advanced Antennas



Tactical Network &  
Communications Antennas

Directional  
Antennas



# Future Force—Medical

Medical



**Improved  
Treatment  
for Head Injuries**

## Combat Casualty Care



**Regenerative  
Therapies**



**Far-Forward  
Resuscitation &  
Hemorrhage Control**



**Semi-Autonomous  
Intensive Care &  
Transport System**

## Infectious Diseases



**Malaria  
Treatment Drugs**

**Malaria  
Prevention  
Vaccines**



**Malaria Rapid  
Diagnostic Device**



**Dengue Prevention  
Vaccines**

## Operational Medicine

**Remote Monitoring  
of Warfighter Health  
and Performance**



**Performance Test  
for Future Lightweight  
Body Armor Systems**

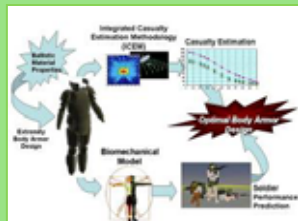




# Future Force—Soldier Systems

**Soldier**

## Survivability

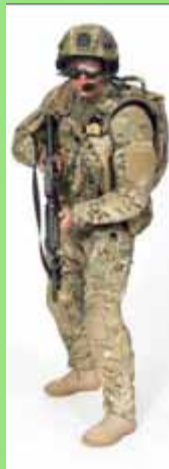


**Modeling & Simulation**



**Novel Fibers for Ballistic Protection**

**Nanomaterials for Ballistic, Laser, Environmental Protection**



**Future Force Warrior**

## Rations

**First Strike Compact Ration**



**Biosensor for Food Safety**



**Joint Combat Feeding**



## Power



**Fuel Cell Battery Hybrid**



**Photovoltaics**



**Stirling Engine**



**Electro-textiles**

## Personnel Technologies

**Accessing, Retaining & Training Adaptive Soldiers & Leaders**



**Realistic, Effective Training**

## Sensors



**Uncooled IR Sensors for UAVs**



**Physiological Status Monitoring**



**Pointer**



# Future Force Warrior (FFW)—2006

- **FFW Increment 1 at C4ISR OTM Jun-Aug 06:**

- Integration into Future Force network via Soldier Radio Waveform
- Current force integration via FBCB2
- Integrated combat ensemble with stand-off body armor/load carriage/electronics and signature management
- Squad level NLOS cooperative engagement
- Headgear with integrated fused thermal and I2
- System voice control

- **FFW Early Increment 2 improvements at OTM 06 and AAEF/Spiral C:**

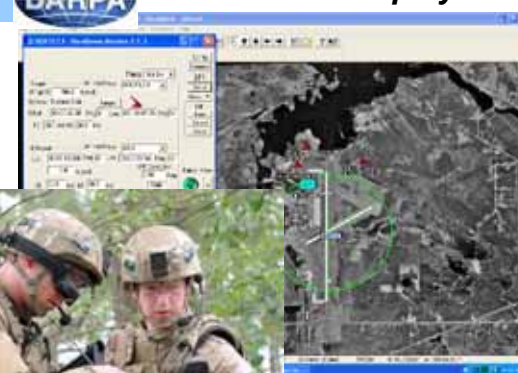
- Beyond squad level NLOS cooperative engagement
- Digital target hand-off to joint platforms (F-16, A-10)
- Class I UAV imagery feed
- Goggle mounted “look down” display
- Physiological status monitoring

- **FFW at C4ISR OTM and AAEF/D in 2007**

- Precise positioning system
- Low power flexible display demo
- Headgear sensor fusion
- Wireless Personal Area Network and weapons interface
- UGV, UGS integration to FFW platform
- Compact computer (Falcon computer from AFRL)
- Apache digital target hand-off



**Leader Display**



**Soldier Display**

**FFW transitions to PEO Soldier in 1QFY08 for Ground Soldier System (next generation Land Warrior)**





# Future Force—Logistics

**Logistics**

## Power & Energy



**Hybrid Electric Drive**

**Heavy Fuel Engine**



**Fuel Cell Development**



**Fuel Cell Development**



**Utility Variant**



**Sustainment Variant**

**Future Tactical Truck System Concepts**

## Deployability



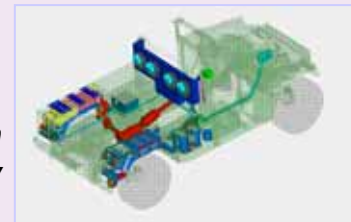
**Lightweight Band Track**



**Precision Air Drop  
30k lbs**

## Sustainment

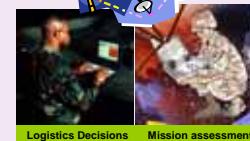
**Water Generation & Recovery**



**EM Gun Munitions**



**Prognostics/Diagnostics**



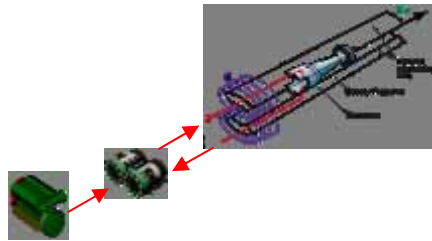
**Logistics Decisions Mission assessment**



# Future Force—Lethality

## Guns and Munitions

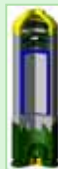
**Electromagnetic Gun...  
paradigm shift  
in propulsion**



**Electronically  
Controlled  
Variable  
Effects  
Warheads**



**Wall Breaching  
Munitions**



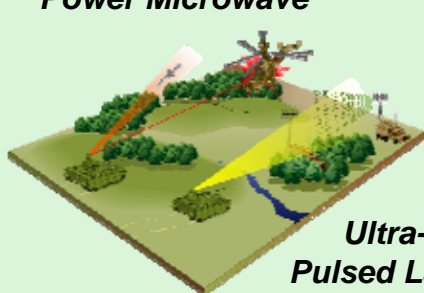
**Small Arms  
Deployable  
Sensor  
Network**



**Urban Assault Munitions**

## Non-lethal

**Multi-Mission High  
Power Microwave**



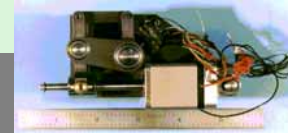
**Ultra-short  
Pulsed Lasers**



## Missiles



**GPS Receiver**



**Control Actuators**

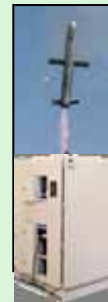


**IMU**



**Guidance & Control**

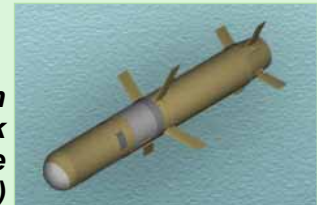
**Future Missile Technology**



**Non-Line of  
Sight Launch  
System  
(NLOS-LS)**

**NLOS-LS and C3**

**Precision  
Attack  
Missile  
(>40km)**

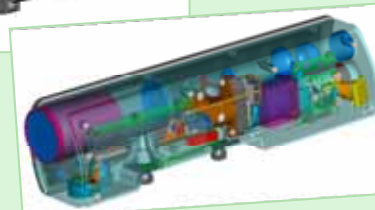
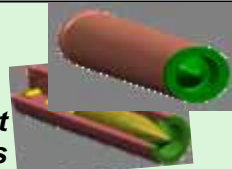


## Joint Small Arms



**Lightweight  
Weapon  
Component  
Technologies**

**Lightweight  
Caseless  
Ammo**



**Target  
Acquisition  
Fire Control  
Sub-system**



# Future Force—Rotorcraft

## Rotorcraft

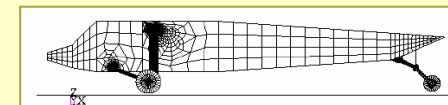
### Reduced Operations and Support Costs

#### Propulsion and Drive Trains

- Increased Fuel Efficiency
- Lighter Weight Components
- Small Heavy Fuel Engine

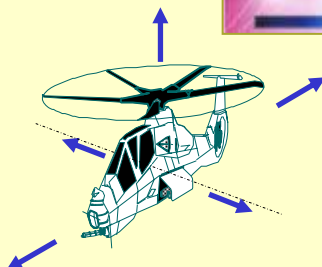


- Reduced Weight/Vibration
- Improved Reliability and Durability



### Rotors and Flight Controls

- Intelligent & Active Rotors and Controls
- Embedded Actuators



### Platform Technology

- Advanced Rotary Wing Concept Designs
- Aviation Weapons Integration
- Directed Energy/Non-lethal Weapons Integration





# ***Current Force—Advanced Simulation***

## ***Advanced Simulation***

### ***Psychological Evaluation and Treatment***



### ***Cultural Awareness Simulation***



### ***Adaptive Learning Environment***







# Joint Fires and Effects Trainer System

## Urban Terrain

- Application of indirect effects in urban battlespace
- Cognitive proficiency for better decision-making



## Fires & Effects Command (FEC)

- Testbed for system and human/machine interface requirements for Networked Fires Command node



## Open Terrain

- Skill and cognitive trainer
- Mounted and dismounted
- Range of “individual” to “collective” tasks



## Close Air Support (CAS)

- Movable flats for mixed reality environments
- 300-degree perimeter field-of-view
- 360-degree overhead field-of-view
- All rear projection







# Future Force—Training Simulation

Adv Simulation

## Training Strategies & Simulation



**Next Generation Training Systems**



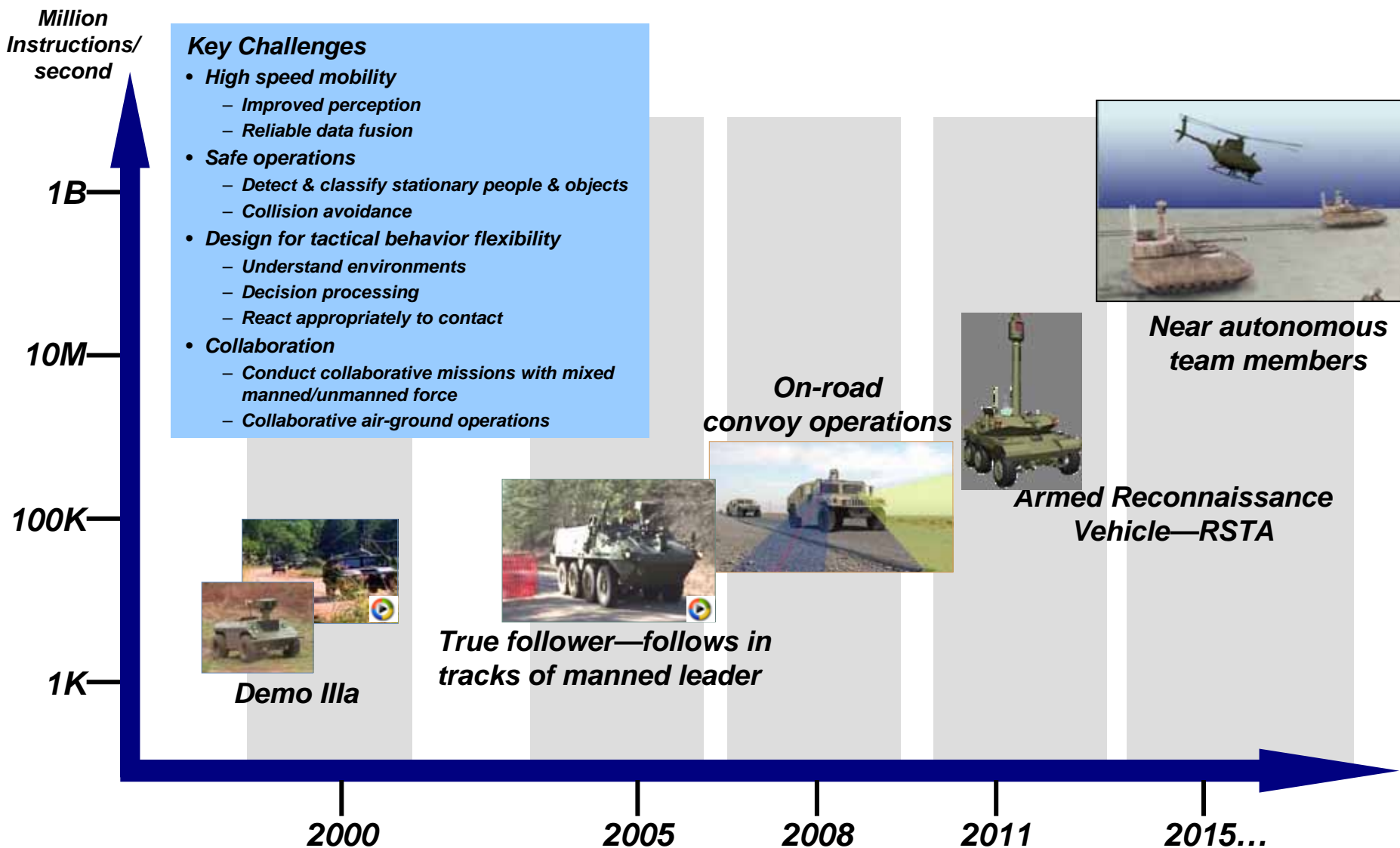
**Army Excellence in Leadership**



**Learning with Adaptive Simulation & Training**



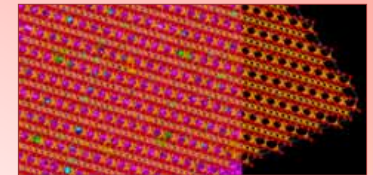
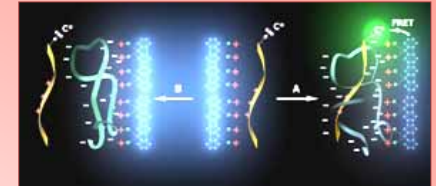
# Progress in Autonomy & Cognition for Operational Capability



# Shortening Cycle Time— Research to Products



*Immersive simulation for training, cultural awareness and mission rehearsal*

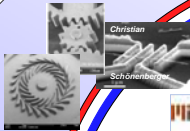


*Bio-inspired materials designs for energy, sensors, and networks*

**Transforming  
knowledge  
into  
Technology**

**Microtechnology**  
1-100 micrometer

**Macrotechnology**  
Millimeter Kilometer



**Nanotechnology**  
1-100 nanometer

**Functional System**



**Soldier**  
~2 meters



*Develop high performance, commercially-viable, conformal and flexible displays*



*Nanotechnologies for Soldier survivability*





# *Army S&T...* **Engine of Transformation**





*The Overall Classification of  
this Briefing is*  
**UNCLASSIFIED**



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# ***Game Changing Technologies***

## **Computational Imaging Systems**

**Timothy M. Persons, Ph.D.**  
**Technical Director and Chief Scientist**  
**Disruptive Technology Office**  
**Office of the Director of National Intelligence**

**April 4, 2007**

**UNCLASSIFIED**

*The Overall Classification of  
this Briefing is*  
UNCLASSIFIED



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# ***How the Disruptive Technology Office is Working to Subvert Pre-21<sup>st</sup> Century Intelligence Business Paradigms***

## **Case Study: Computational Imaging Systems**

**Timothy M. Persons, Ph.D.**  
**Technical Director and Chief Scientist**  
**Disruptive Technology Office**  
**Office of the Director of National Intelligence**

**April 4, 2007**

UNCLASSIFIED

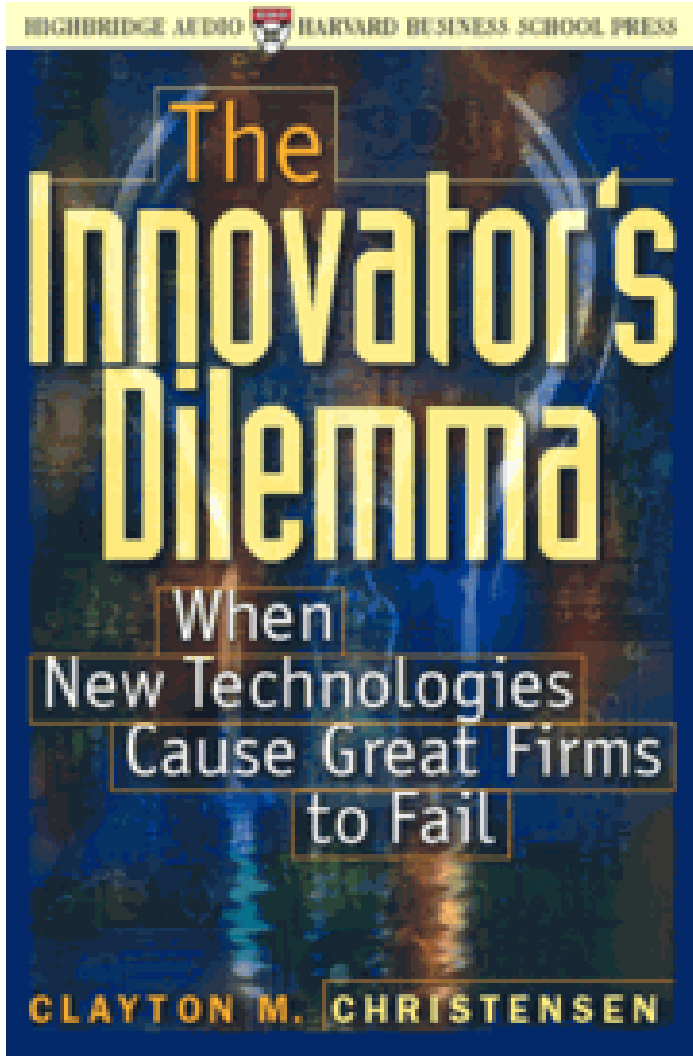


# *The Nation's Intelligence Community*

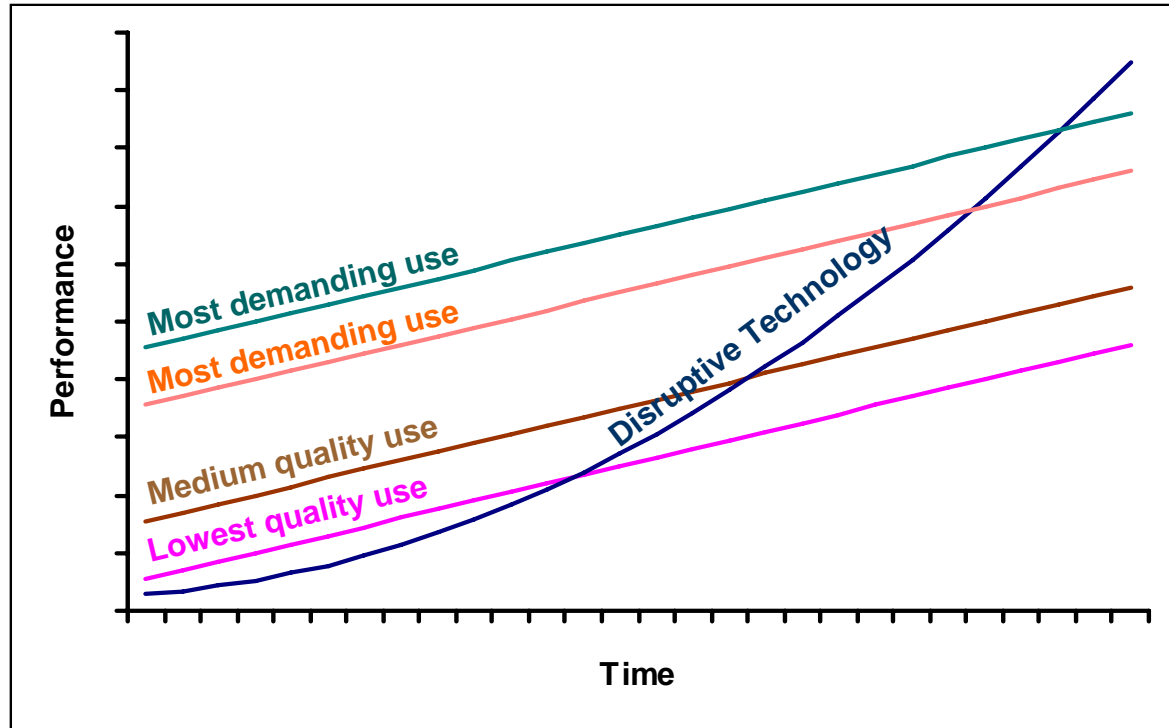




## The Innovator's Dilemma



Christensen, Clayton M. *The Innovator's Dilemma*, Harper Business, 1997, 286 pages



### Established Technology

Silver halide photo film

Wireline telephony

Manned fighter & bomber aircraft

UNCLASSIFIED

### Disruptive Technology

Digital photography

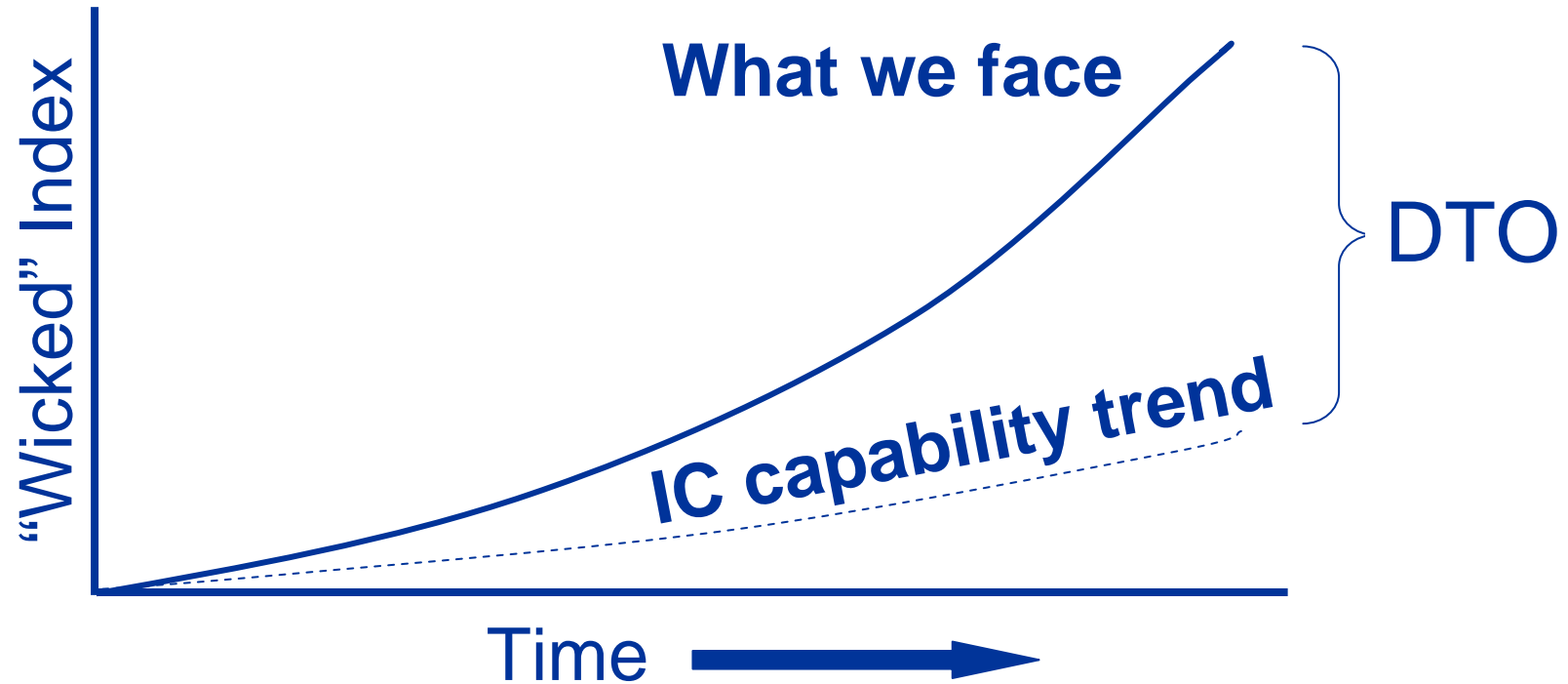
Mobile telephony

Unmanned aircraft





## *DTO Addresses “Wicked” Problems*

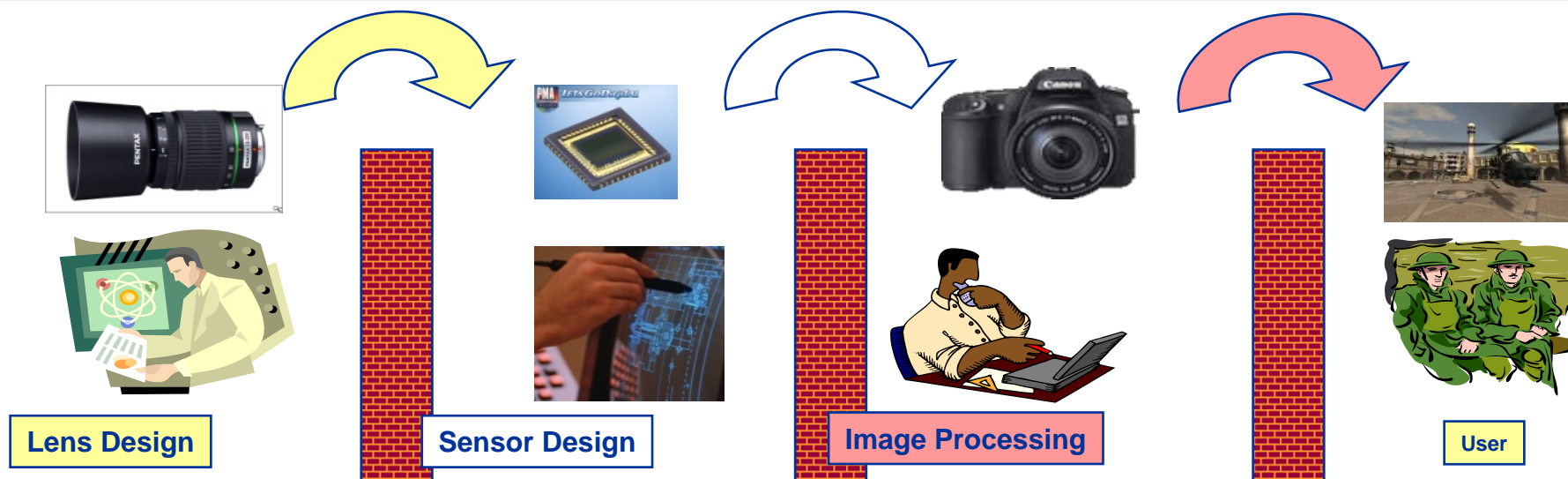




# Conventional Approach to Designing Imaging Sensors

## n Current imaging sensor design strategy:

- Separately designed and optimized subsystems/components bolted together
- Fixed allocation of resources at design time
- Feed-forward information flow only



## Case Study for a Hypothetical Sensor:

**Data generated =  $1024 \times 1024$  (spatial)  $\times$  200 (spectral)  $\times$  8 bits = 200 MB / frame**

**Information extracted from a typical tactical scene = 100 objects of interest  $\times$  4 B/object = 400 B**

**(Information / Data) =  $10^{-6}$  ...VERY POOR EFFICIENCY**

# Current High Performance Imaging Sensors



Predator Camera

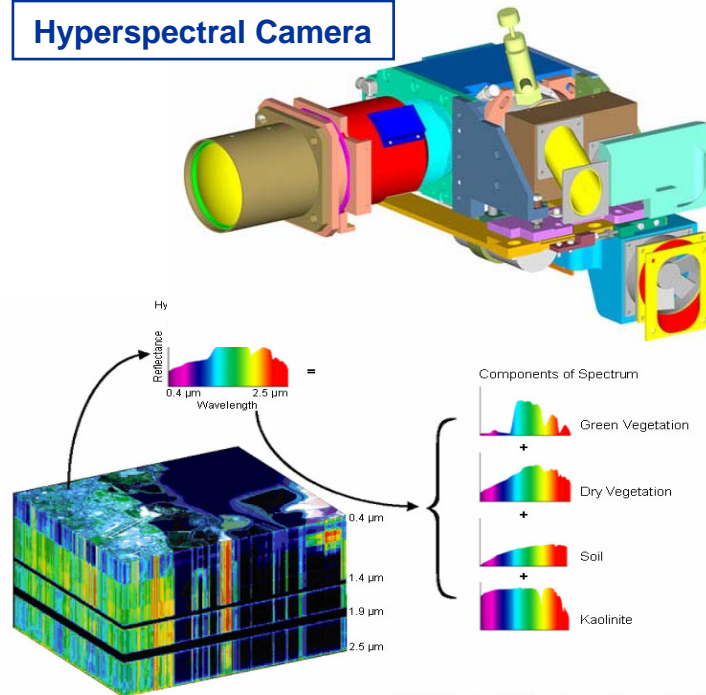


Predator Ladar



39 Megapixel Hasselblad

Hyperspectral Camera



(NEMO Project Office, United States Navy)

## Technology Scaling Driven by “Moore’s Law”

- 3D, hyperspectral, polarimetric, Doppler Ladar....
- More detector pixels, more spectral bands, higher frame rates....
- Governing philosophy: **“More data is better data”**



## *Definition of Computational Imaging Systems*

- ❑ Sensing systems that exhibit jointly optimized optics, transduction, algorithmic, form factor, power, and information factors which together are tunable and exhibit semi to fully autonomous, purposeful<sup>1</sup> sensing.
- ❑ Such systems have experimentally exhibited the following features:
  - ❑ Digital super-resolution
  - ❑ Depth of field extension
  - ❑ Logarithmic dynamic range adjustment
  - ❑ Multispectral
  - ❑ Low aspect ratio (slim form factors)
  - ❑ Polarimetric
  - ❑ Wide FOV

<sup>1</sup>*Purposeful sensing:* application-specific sampling with optimal allocation between space, intensity, spectrum...





# Oldest Computational Imaging Sensor: Michelson Stellar Interferometer

A. A. Michelson, "Visibility of Interference-Fringes in the Focus of a Telescope,"  
Phil. Mag. 31, 256-259 (March 1891).

*Astronomical Society of the Pacific*, 217

## VISIBILITY OF INTERFERENCE-FRINGS IN THE FOCUS OF A TELESCOPE.\*

BY ALBERT A. MICHELSON.

When the angle subtended by an object viewed through a telescope is less than that subtended by a light-wave at a distance equal to the diameter of the objective, the form of the object can no longer be inferred from that of the image. Thus, if the object be a disk, a triangle, a point, or a double star, the appearance in the telescope is nearly the same.

If, however, the objective is limited by a rectangular slit, or, better, by two such, equal and parallel, then, as has been shown in a former paper,† the visibility of the interference-fringes is, in general, a periodic function of the ratio of  $\alpha$ , the angular magnitude of the source in the direction perpendicular to the length of the slits, and  $\alpha_0$ , the "limit of resolution." The period of this function, and thence  $\frac{\alpha}{\alpha_0}$ , may be found with great accuracy; so that

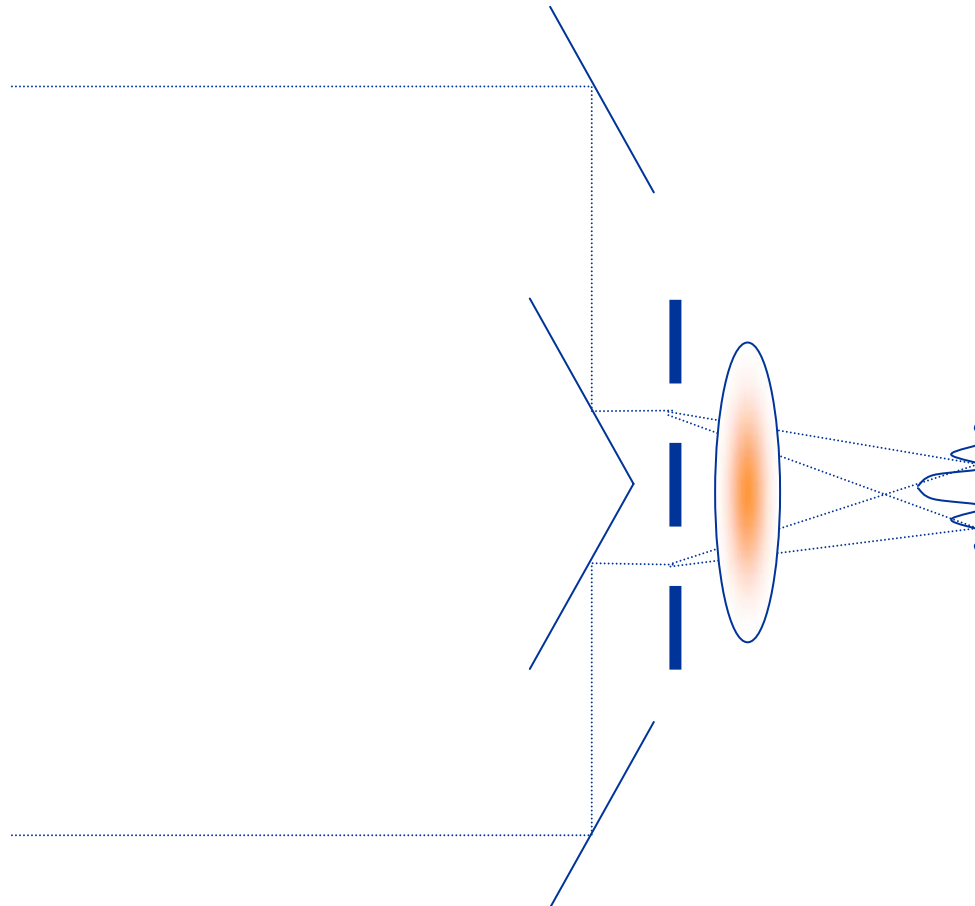
by annulling the greater portion of the objective the accuracy of measurement of the angular magnitude of a small or distant source may be increased from ten to fifty times. As ordinarily understood, this increase of "accuracy" would be at the cost of "definition" (which, in this sense, is practically zero); but if by "definition" we mean, not the closeness of the resemblance of the image to the object, but the accuracy with which the form may be inferred, then definition and accuracy are increased in about the same proportion.

In almost every case likely to arise in practice, the form of the source is a circular disk; and if the illumination over its surface were uniform, the only problem to be solved would be the measurement of its diameter. But in many cases the distribution is anything but uniform. If the curve representing the distribution along the radius be  $i = \psi(r)$ , then the element of intensity of a strip  $y, dx$  will be

$$\int_{-r_1}^{r_1} \psi(r) dy = \phi(x),$$

\* Reprinted, by request, from the *Philosophical Magazine*.

† "On the Application of Interference Methods to Astronomical Measurements" (Phil. Mag., July, 1890).





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# Automotive Analogy for Imaging Sensors



Horse-drawn Carriage



Horse-*less* Carriage



Film Cameras



Film-*less* Cameras

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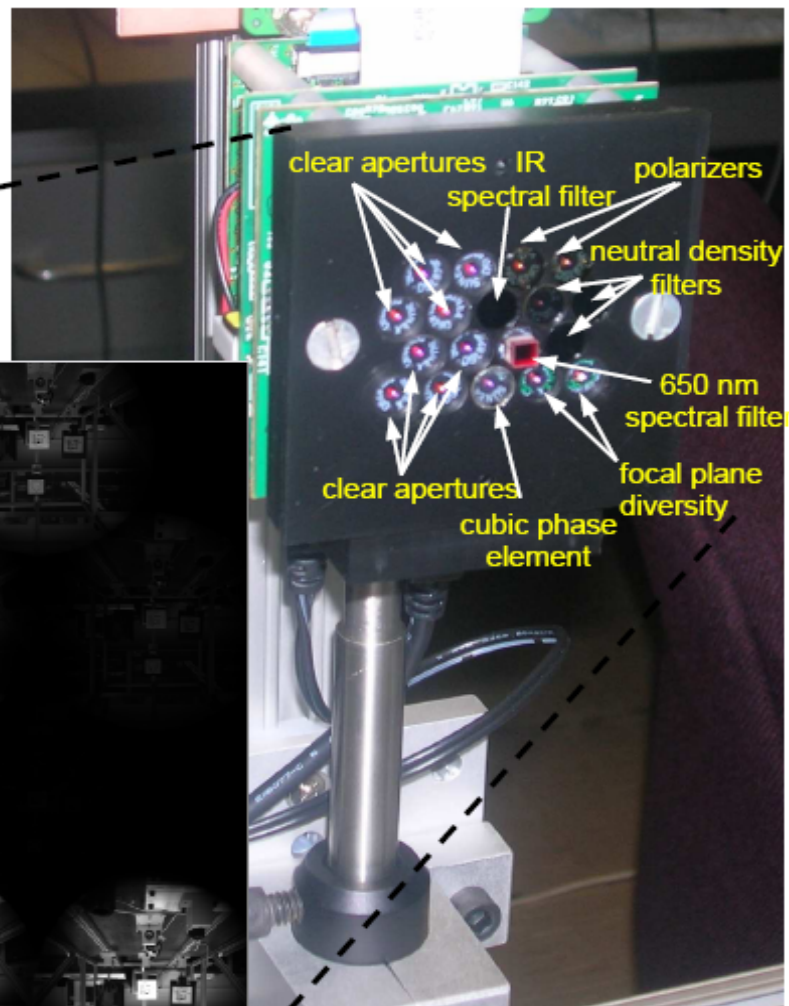
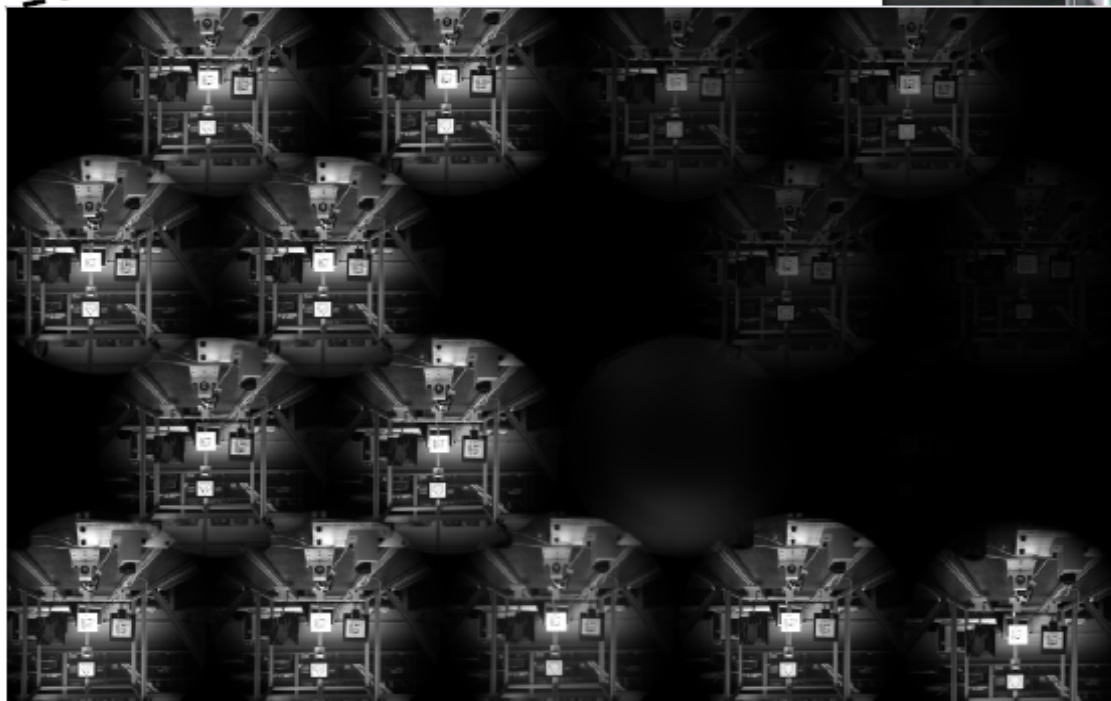
Specialization?  
Autonomy?



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# *Multi-Aperture, Multi-Diversity Compact Imager: PERIODIC Seedling*

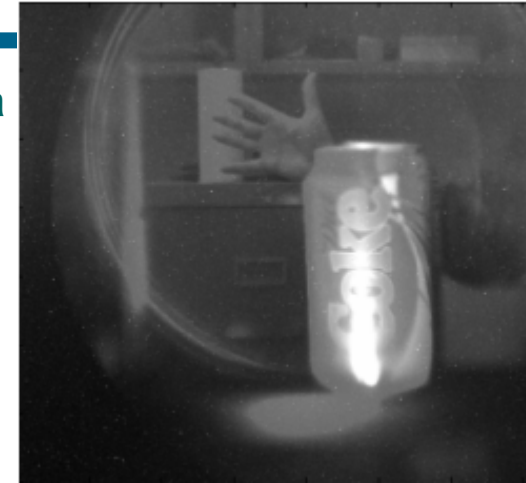
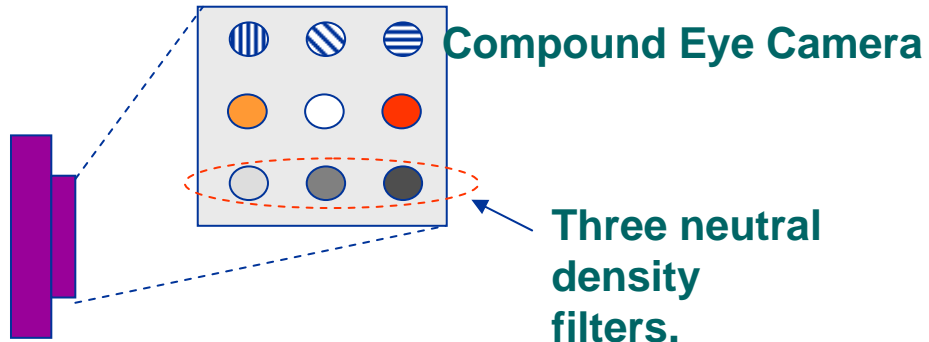
Full 10.8 MPixel Image



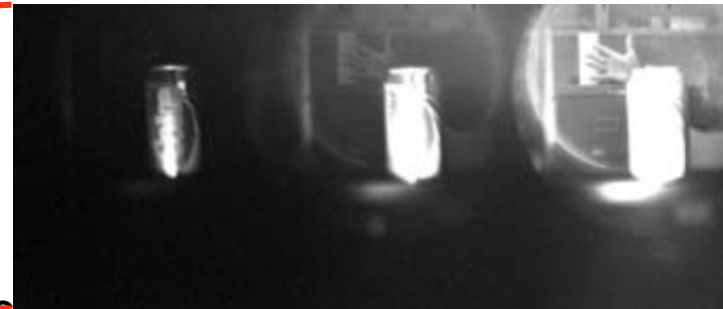
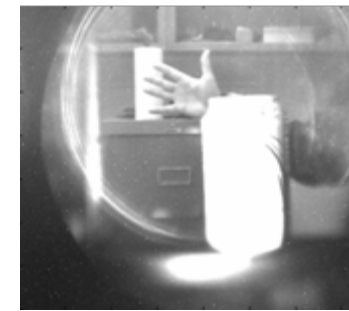
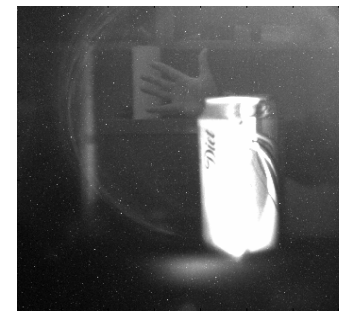
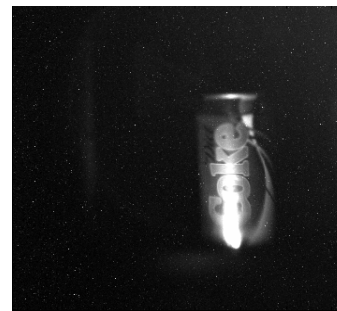
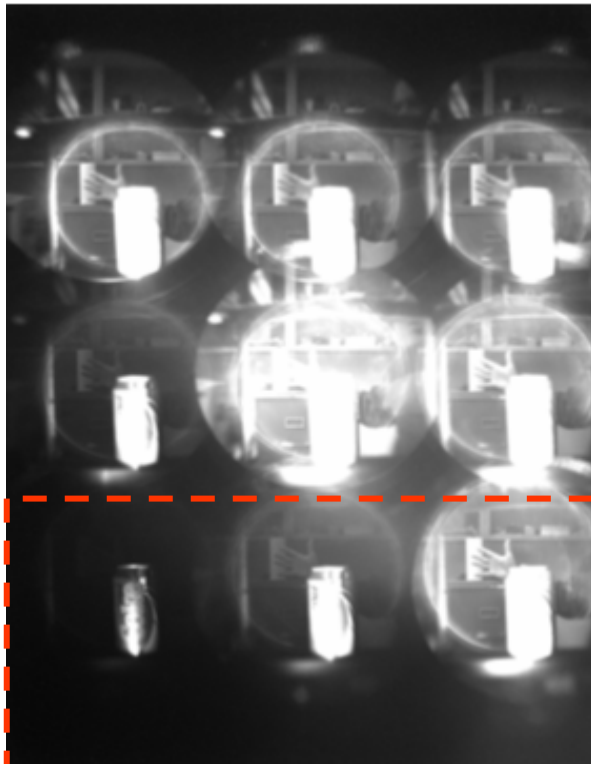
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## *PERIODIC Demonstration*



Combining subimages using three different neutral density filters can be used to improve dynamic range



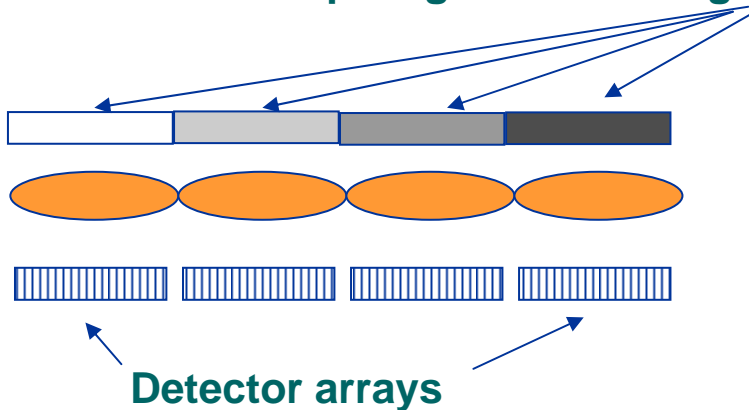




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# Imaging of High Dynamic Range Scenes – Conventional vs. *PERIODIC*

Simple light attenuating filters



- Place different neutral density filters in different 'subimagers.'
- Capture image
- Perform image computation



Short exposure time needed to see details in bright regions  
Long exposure time needed to see details in shadow regions  
Some portions of scene underexposed  
Rest of scene overexposed  
Some overexposed  
Rest of scene underexposed

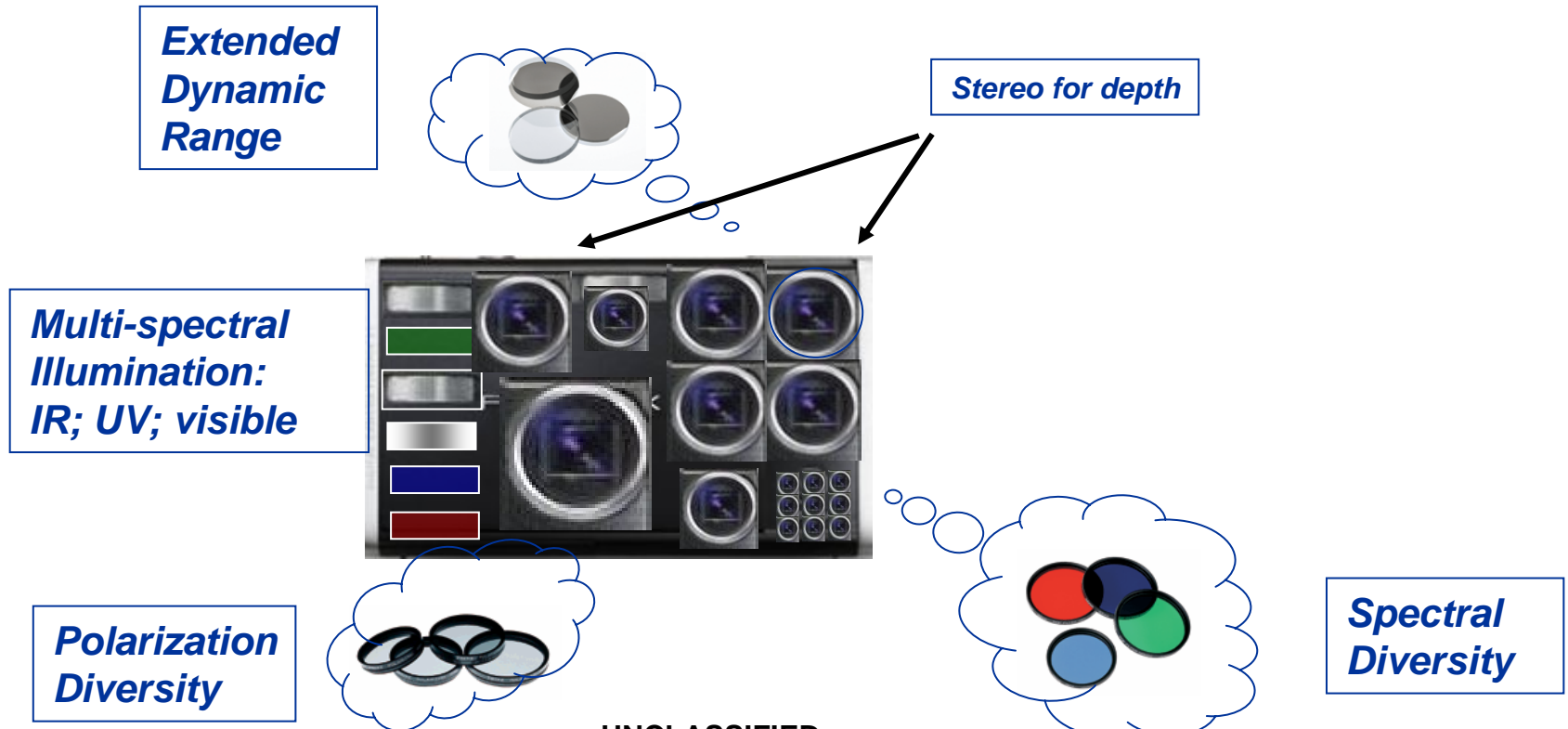
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# Next Generation System CONOPS

## The "Swiss Army" Imaging System

- Multi-aperture architecture with **dynamic** diversity elements
- Multi-spectral, broad-band sensing (visible-LWIR)
- Multi-band illumination for chem-bio sensing
- Optimized Integration with post-processing and display
- Ultra-thin aspect ratio





**Computational Imaging Systems =**

**Nanophotonics + Megapixels + Gigaflops + Form Factor + Power**

*Jointly designed and optimized*

**Mission Goal:**

**Purposeful, Semi to Fully Autonomous Sensing**



*Thank you*







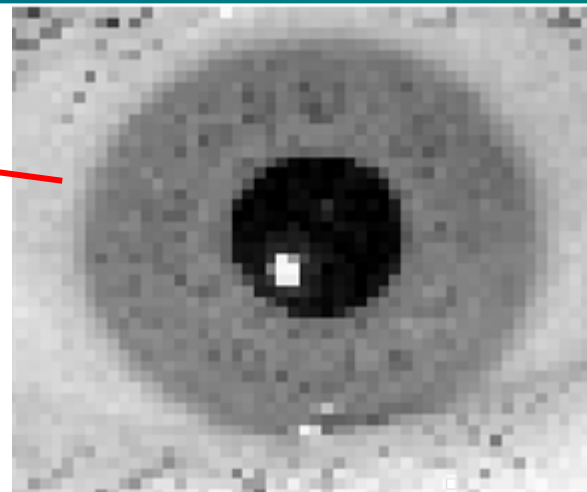
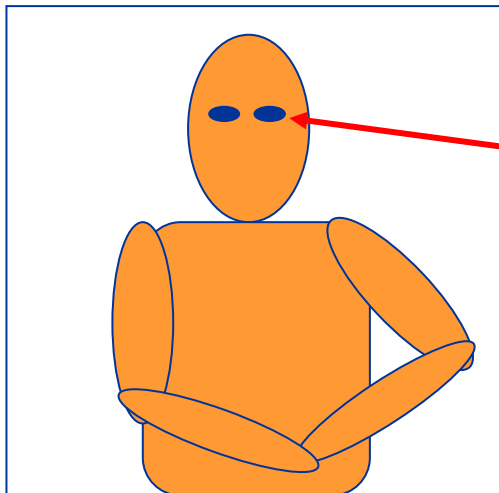
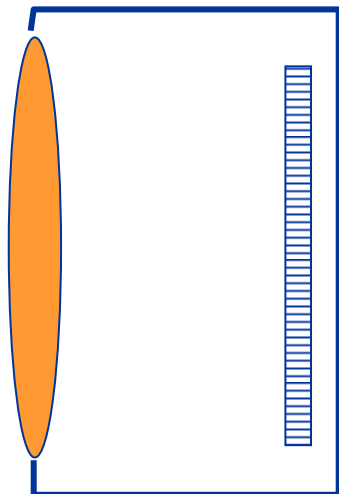
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# BACKUP

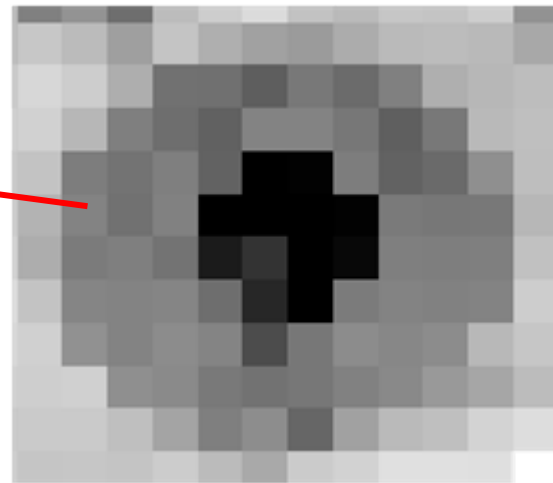
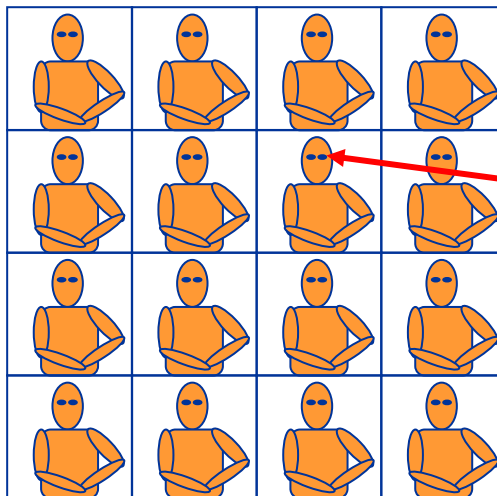
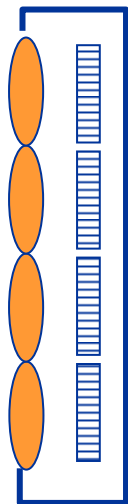


## Form Factor Reduction

Standard system



PERIODIC system



If the images are acquired such that they are shifted with respect to each other by subpixel amounts, the full resolution image can be restored subject to noise and other uncertainties.



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Dynamic Range Diversity

*Example of a 3 x 3 Array*

Wavelength Diversity

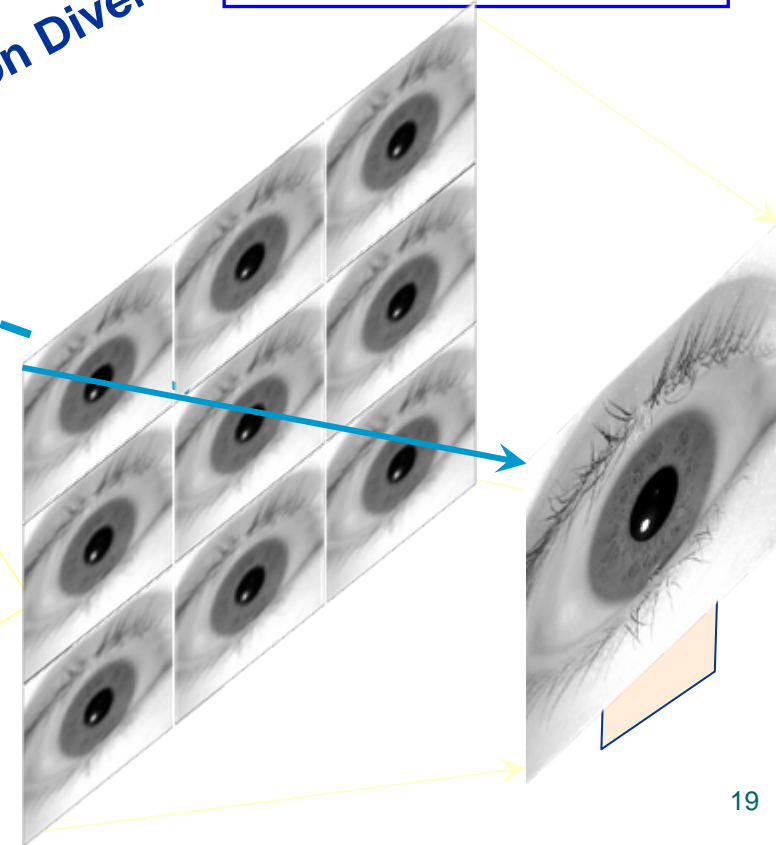
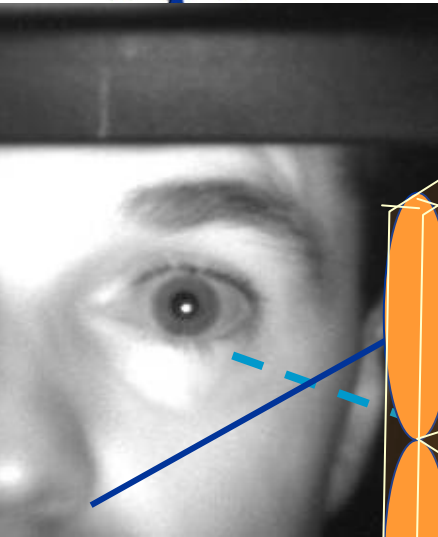
Polarization Diversity

Imaging Axis

Optical/Diversity  
Subsystem

Sensor Array

3 x 3 LOW-DEF  
images post-  
processed into one  
or more HIGH-DEF  
image



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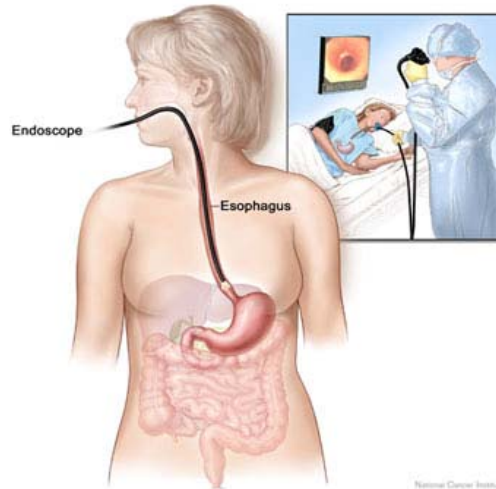


# Digital Cameras....all shapes and forms!

*But they all operate the same way*



Note: The image will be a mirror image.







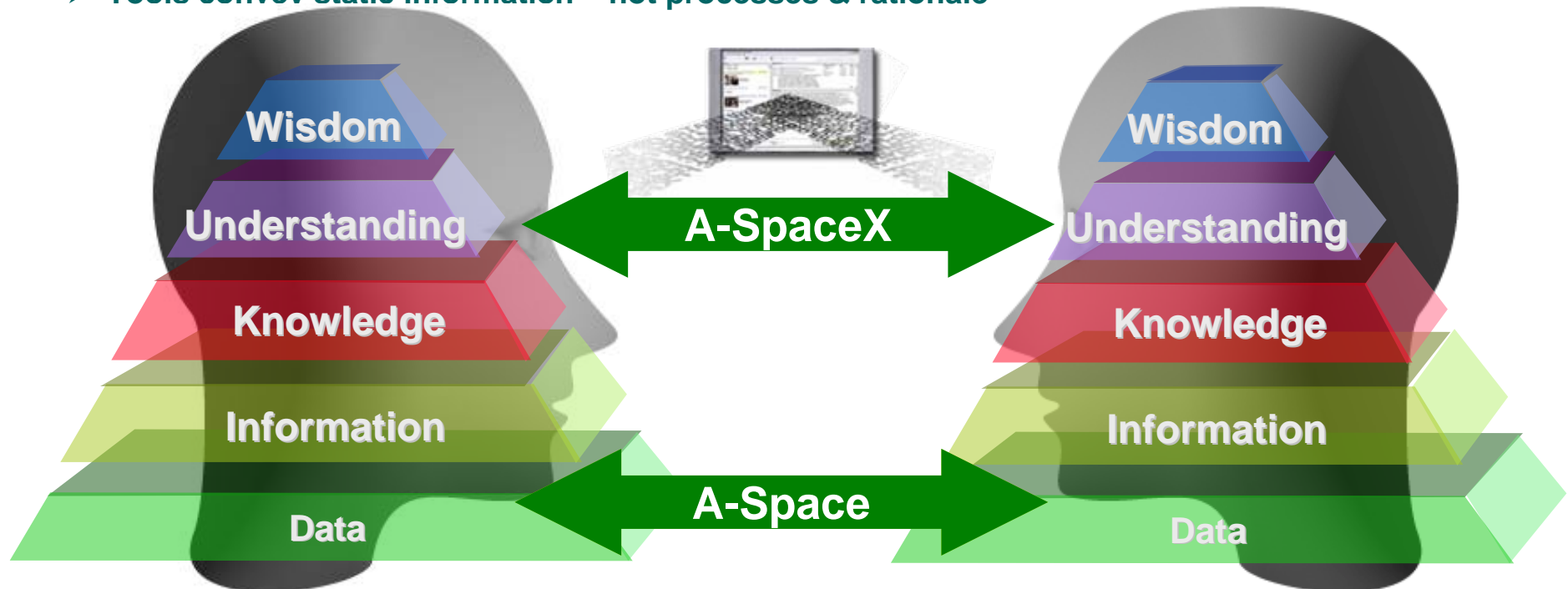
## *MMP Collaborative, Multi-INT Systems*

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## Operational Problems

- ❑ Too much data – not enough information!
  - Multiple, poorly defined threats make it make it hard to know what is salient.
- ❑ Conventional visualizations do not readily support analytic processes
  - Decision making highly branched & iterative characteristic of analytic processes
  - Hypotheses abandoned today may be salient tomorrow
  - Context is key to framing and understanding the problem –
- ❑ Sharing is hard – Understanding is collective!
  - Sharing uncertainty is at odds with IC culture
  - Tools convey static information – not processes & rationale

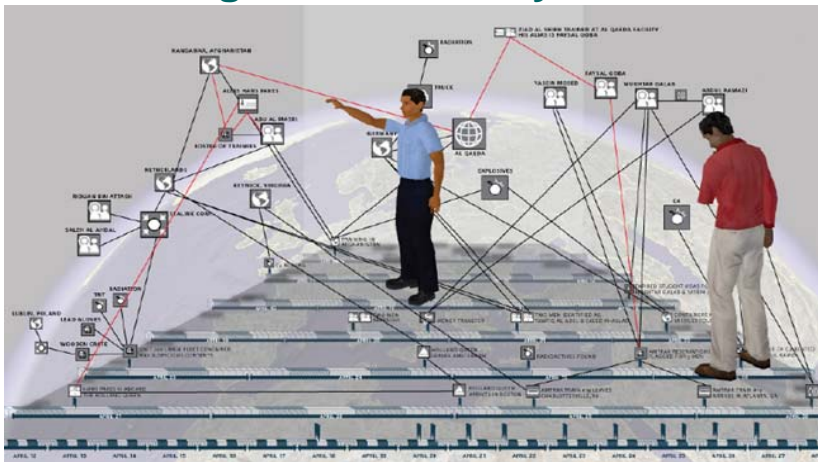


## □ Web-enabled Technologies

- Modern & next generation browsers support advanced visualizations
- Web technologies consistent with Services Oriented Architecture (SOA)
- Multiple Visualizations readily derived from shared data sources

## □ MMRPG technology viable

- Readily available
- Next-generation analysts are comfortable



## □ Models maturing

- Models as games,
- Models as processes
- Products inter-operable

## □ Agent Technologies & Automation

- IC is making major commitments to upgrade infrastructure. (A-Space)

***A-SpaceX has a unique opportunity to impact the future of the IC!***



## *Example Environment*





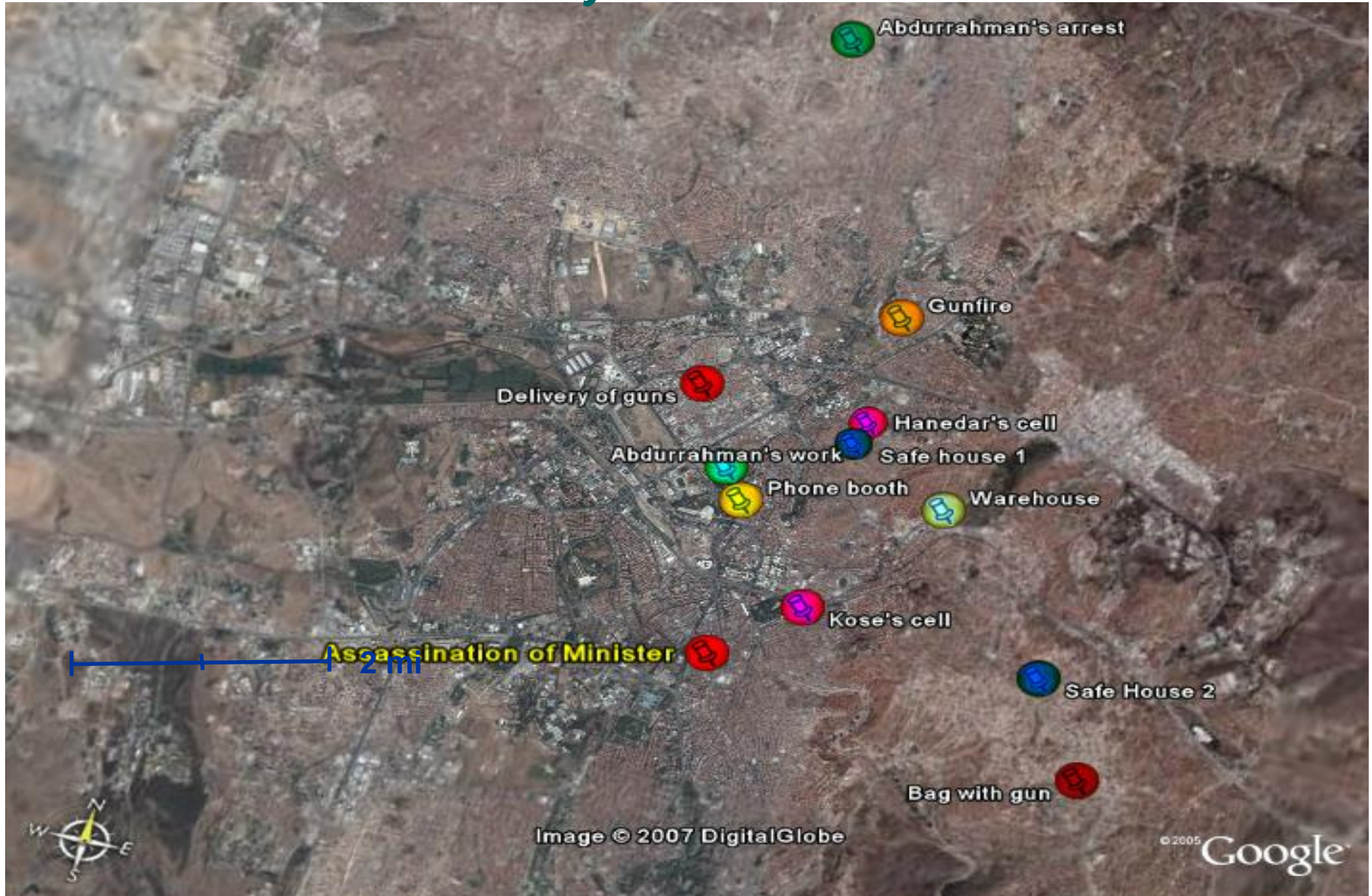


# *Geospatial Profiling for Counter-Terrorism*

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# Geospatial Profiling for Counter-Terrorism

## Case Study: Assassination of Turkish Minister





# *Proactive Intelligence Analysis*

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## Why Proactive Intelligence (PAINT)?



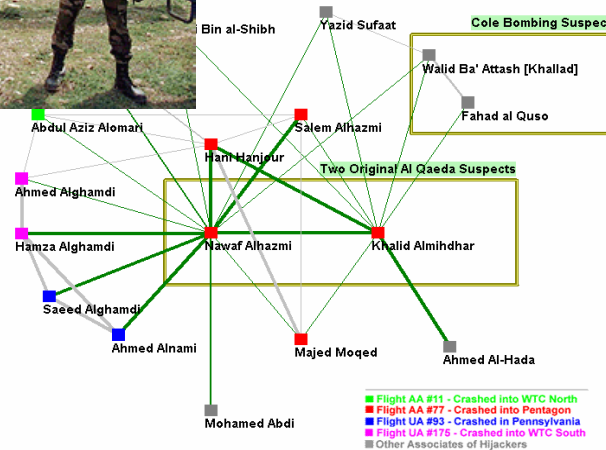
Cyber attack

Weeks to recover



Bioterrorism

Pandemic in days



Terrorism Attack

Disruptive Change

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## *Proactive is Essential*

### **Smallpox attack exercise without proactive warning or plans has dire consequences**

- **Rotterdam port, world's 2<sup>nd</sup> largest, closes**
- **Polish citizens stream to Germany for scarce vaccine**
- **Debate on closing borders, quarantining cities, and limiting the movement of people**
- **World Health Organization lacks authority**





## PAINT's Approach

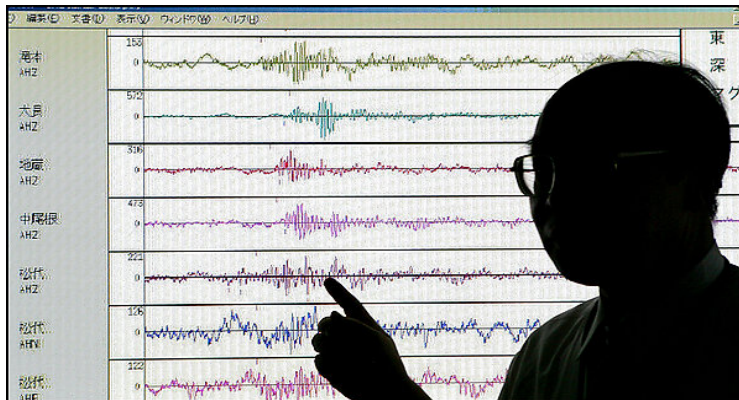
### Project Forward



Doomsday Clock moves closer to midnight by two minutes due to nuclear weapons programs in Iran and North Korea.

-February 25, 2007, Board of Directors of the *Bulletin of the Atomic Scientists*

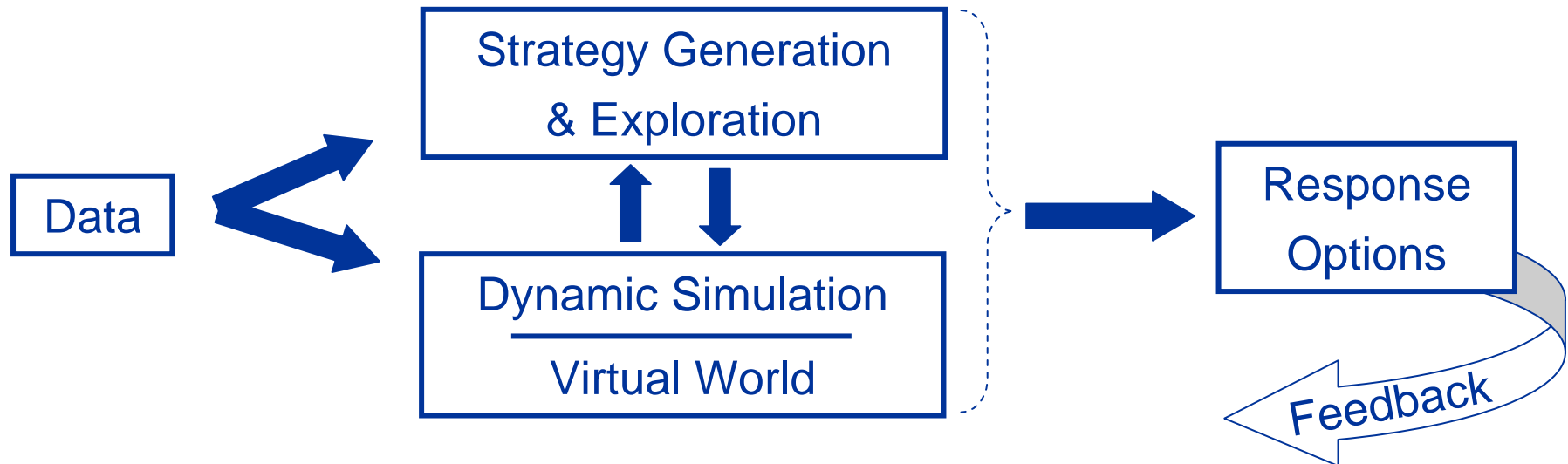
- Explore strategies & identify response points



- Monitor test areas
- Disrupt supply chain
- UN trade ban re uranium enrichment
- UN diplomatic & economic incentives
- US financial sanctions



## *What's New in PAINT's Approach?*



### Near-term

**Timely:** Rapid ID of causal relationships in diverse data sets

### Mid-term

**Adaptive:** Construct models to handle sparse & ambiguous data

**Semi-autonomous:** cultural, environmental & threat models formulated with “light touch”

**Integrated:** Strategy tests with dynamic simulations & virtual worlds

### Goal

***Project future threat developments and identify response options***



# **Strategic Challenges in the Asia-Pacific Region**

## ***Three Waves of Five...& Some Trends Ahead***

LTG (Ret) Ed Smith  
Director, APCSS





# With us now:

1. The attraction of terrorism to those disadvantaged and with little hope.

- An opportunity for identity; a means to act
- Enablers:
  - Socio-economic gaps
  - Transnational crime
  - Globalization (seamless internet effectiveness)



# With us now:

2. The limiting effect of corruption, particularly within governments, throughout the region and the world.

- Pervasive
- Enervating
- Tolerated, too often by many



# **With us now:**

3. Political polarization leading to extremist views...AND diminishing shared values.

- Interest→Identity→Values clashes
- Strategic alignments—major actors
  - PRC-Russian security cooperation
  - PRC-South Asian nations
  - Entire region positioning, given PRC economy
  - US presence, a security ctr-weight



# **With us now:**

4. Disrespect due to a lack of appreciation for cultural/racial/ethnic diversity.

- Rooted in intellectual, ethnic, racial, social, & psychological arrogance
- Fundamental to collaborative progress
- Ldr-to-ldr relationships “decide the day”





# **With us now:**

## 5. Extremes in educational opportunities.

- Deeds, not words
  - Availability
  - Quality
  - Access
- Why not main effort collaborative prioritization?



# **With us now, or ...on the horizon:**

1. Extremes in human security due to the growing have and have-not gaps the world over.
- Demographic profiles identify possible security threats
  - Socio-economic trends are key



# **With us now, or** **...on the horizon:**

2. Interruptions in information-technology networks that impact global security.

- Info-age absolute dependence on IT, especially in the economic and military dimensions.
- Are “degraded-mode” operations still an alternative?
  - F-22s
  - World financial systems



## **With us now, or** **...on the horizon:**

### 3. Environmental effects

physically impacting large portions of the region/world due to unchecked global warming.

- Fact: global economic competition driving adverse environmental impacts
- Energy security gained using less environmentally threatening energy sources





## **With us now, or ...on the horizon:**

4. Over-extension of multinational and multilateral forums intended to foster collaboration on security-cooperation opportunities.

- UN simultaneously in crisis & demand
- Many international orgs face calls for reform (UN, WTO, IMF)
- Shaping potential of Asia-Pacific forums...impacts?



# **With us now, or** **...on the horizon:**

5. Uncontrolled means of mass destruction and/or mass chaos.

- Unraveling global nonproliferation
- Nuclear wpns: security asset or liability?
- Shock event→Chaos, in info age
  - Dirty bomb, or atk on nuclear reactor
  - Low-tech tactics also show potential



# **With us now,** **or on the horizon, ...** **but translucent**

1. Conflict over scarce and valuable resources and/or disputed territory believed to contain such resources.
- For example, potable water in South Asia...or anywhere else



# **With us now,** **or on the horizon, ...** **but translucent**

2. Balancing country X's demand for increased power and influence and the willingness of other major actors to accommodate this.

- PRC
- India
- Smaller countries on the rise (Vietnam)





# **With us now,** **or on the horizon, ...** **but translucent**

3. Mutating pandemic disease among humans.

- “One in ten chance of human-to-human transmission in next ten yrs.”
- World health orgs not as confident
  - Not “if” but “when”
- What type, where, by whom, & how much prep is enough?



# **With us now,** **or on the horizon, ...** **but translucent**

4. Understanding, and managing, reactions to the perceived threat of information globalization to cultural identity.

- Pursued “inside out”
- Grounded in promise, not fear
- Transforming from power to coerce to power to aid



**With us now,**  
**or on the horizon, ...**  
**but translucent**

5. Leaders without a vision that serves the common good...the harder right.

- How do we develop leaders with such vision?



# So What?

- If these are trends, how do we influence and shape them, to advantage? Or, mitigate those we cannot shape?

A couple final thoughts...





# Final Thoughts

- Security challenges have always been complex, but perhaps the nature of the complexity today is shifting
- **Ways** (problem analysis), toward solutions, require “centering” highly dynamic, diverse knowledge/people relationships and their impacts on organizational potential
- **Means** must be adapted to applications in very different social & cultural frameworks
- **Ends** sought → conditions v. endstates

# KNOWLEDGE DISCOVERY

## From Situational Awareness to Bomb Damage Assessment

LTG (Ret) George A. Fisher  
Oak Ridge National Laboratory

**“Connecting the Dots”**



**“All I’m saying  
is, now is the  
time to develop  
the technology  
to deflect an  
asteroid.”**

# A Couple of Facts

~~Manual~~

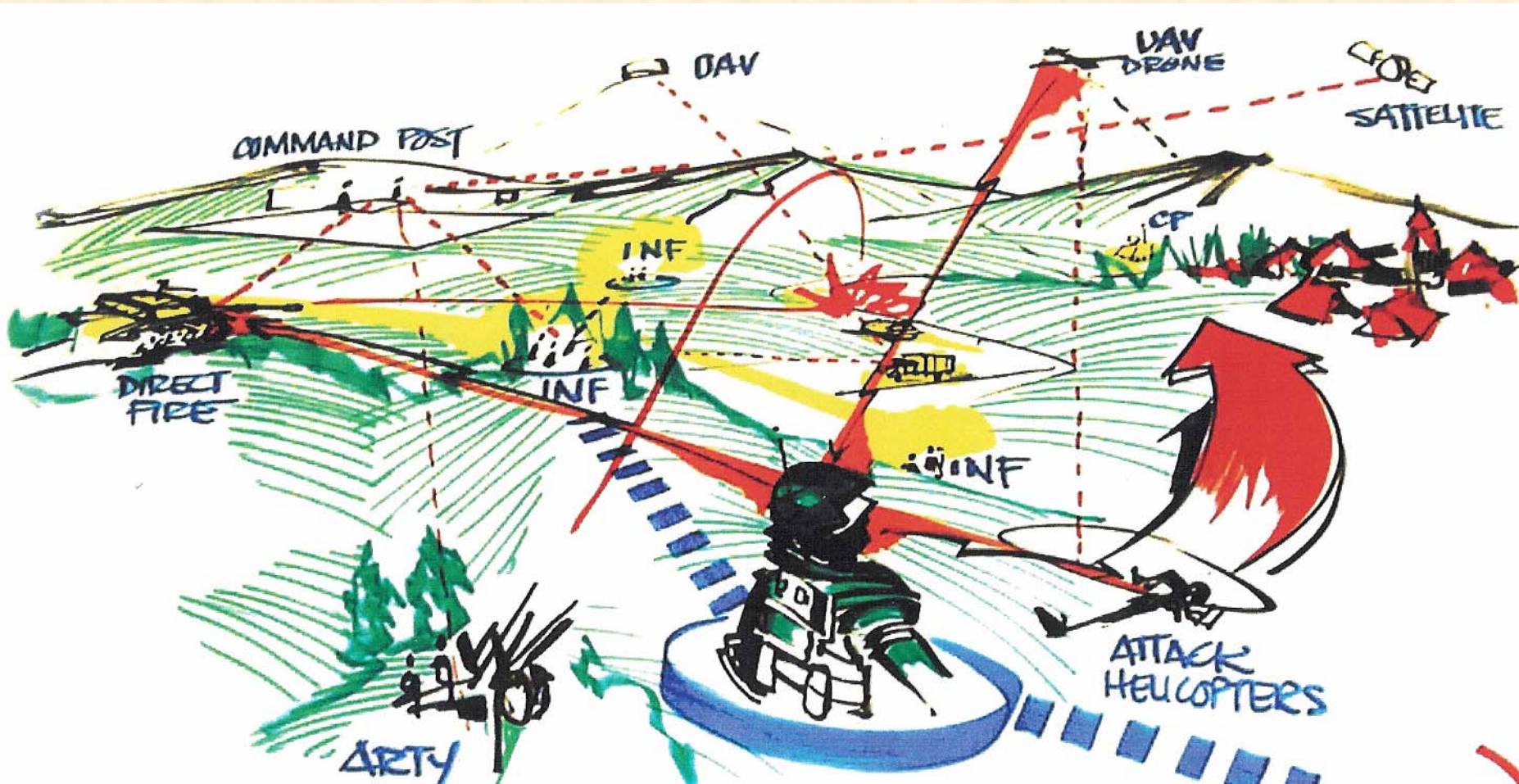
**The Brigade  
Combat Team of  
2015 can expect  
3,178,800 sensor  
reports per hour  
in its area of  
operations**

~~Client  
Server~~

**In 2006, the  
amount of  
digital  
information  
created was 3  
million times  
all the books  
ever written**



# THE 2020 War Fighter



**“Know what the Network Knows”**

# Challenge – What to do with this?



- **What is in there?**
- **Are there any threats?**
- **What am I missing?**



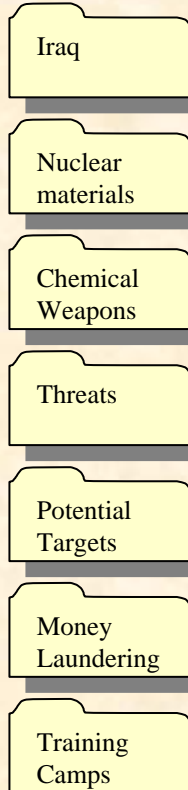
# Connecting the Dots

## Raw Documents



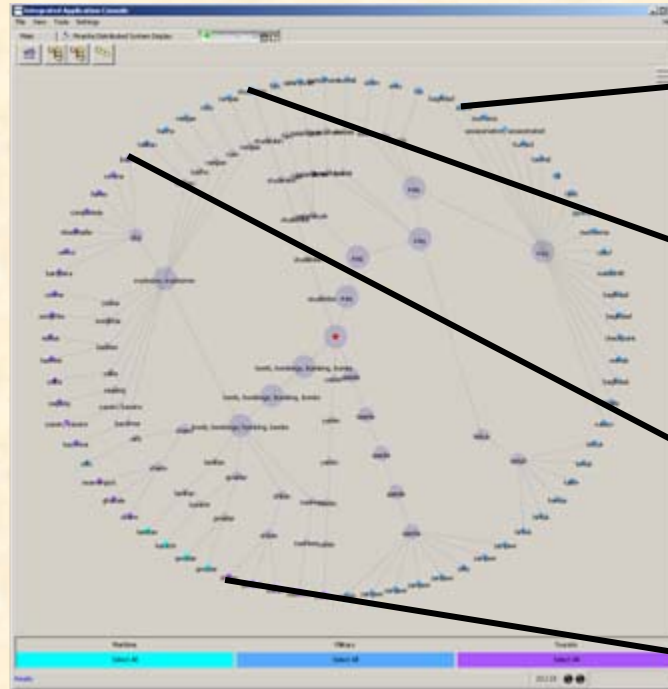
What do we have?

## Organize the Information



What are the connections?

## Connect the Information



What are they planning?

## Find the Threats



How credible is the threat?

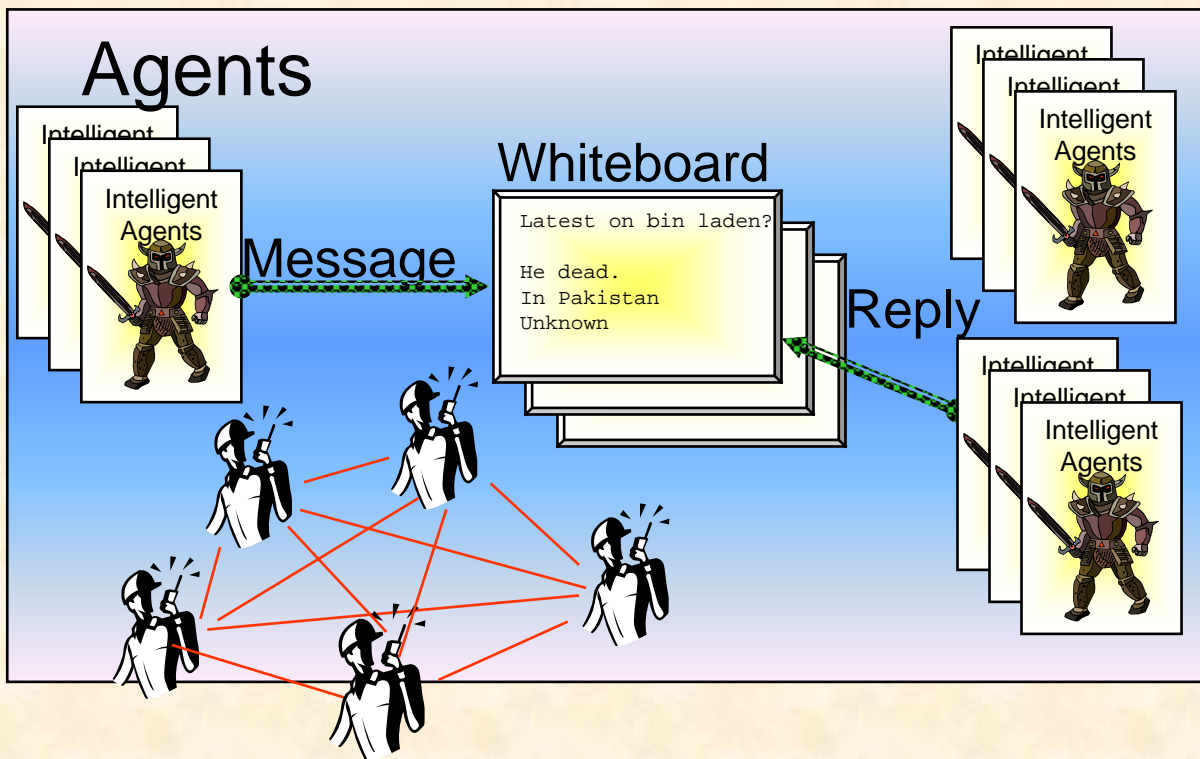
## Take Action



# Intelligent Software

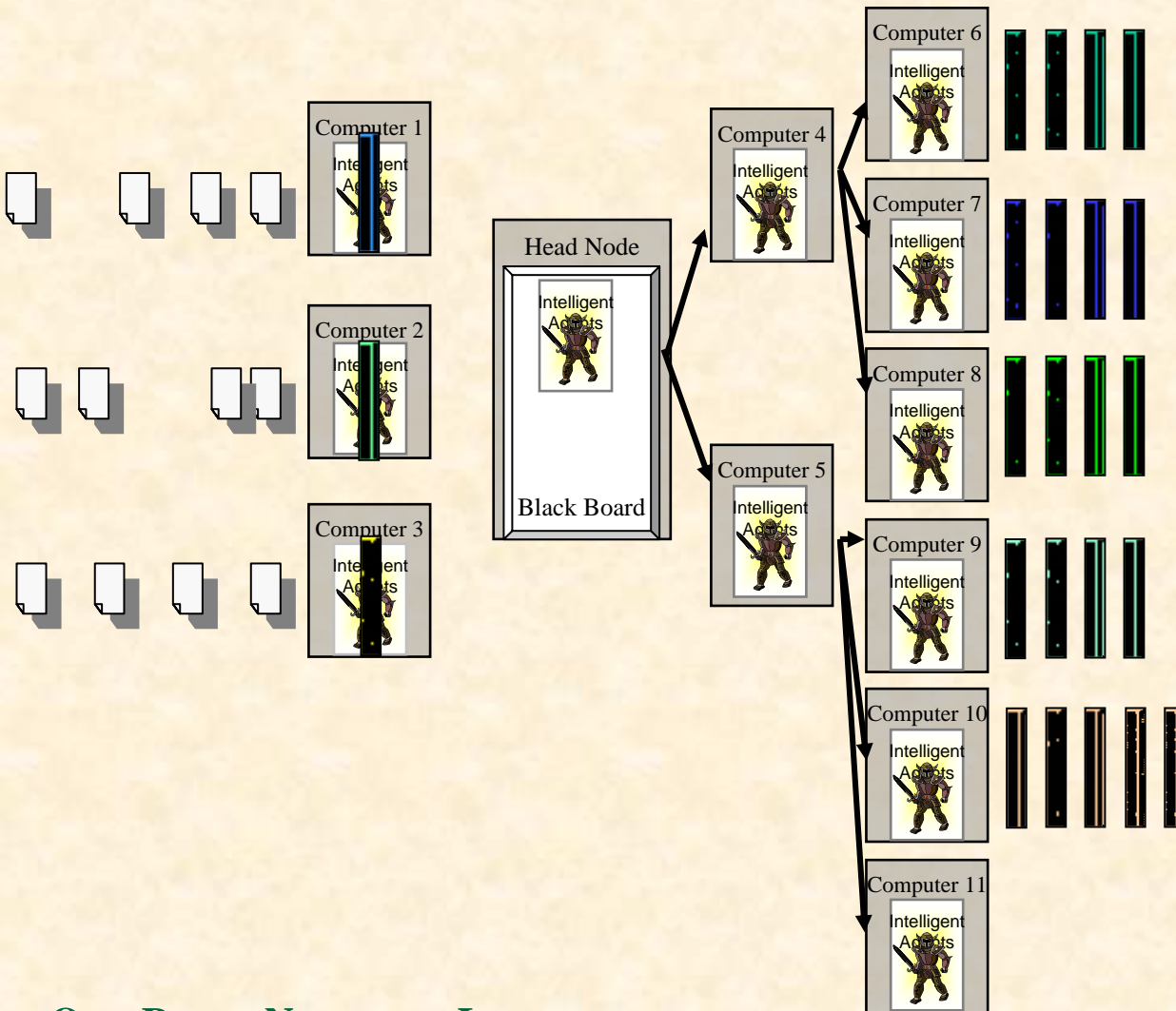
## • Intelligent Agents

- Software processes
- Can communicate in unstable environments
- Form teams to solve problems
- Live, die, and reproduce to solve problems





# Agent Approach

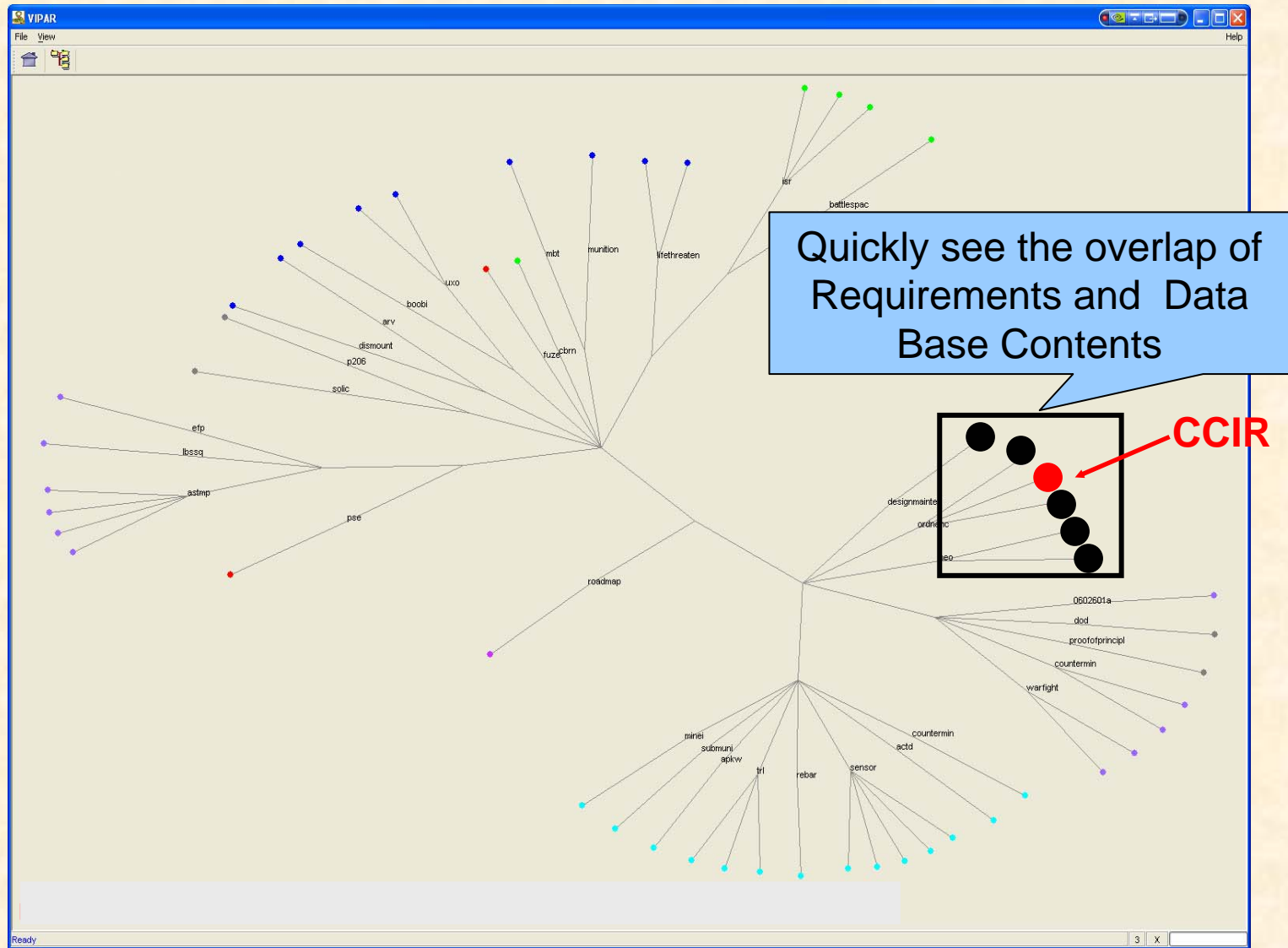


- Standard Approach  
**11.5 Days**

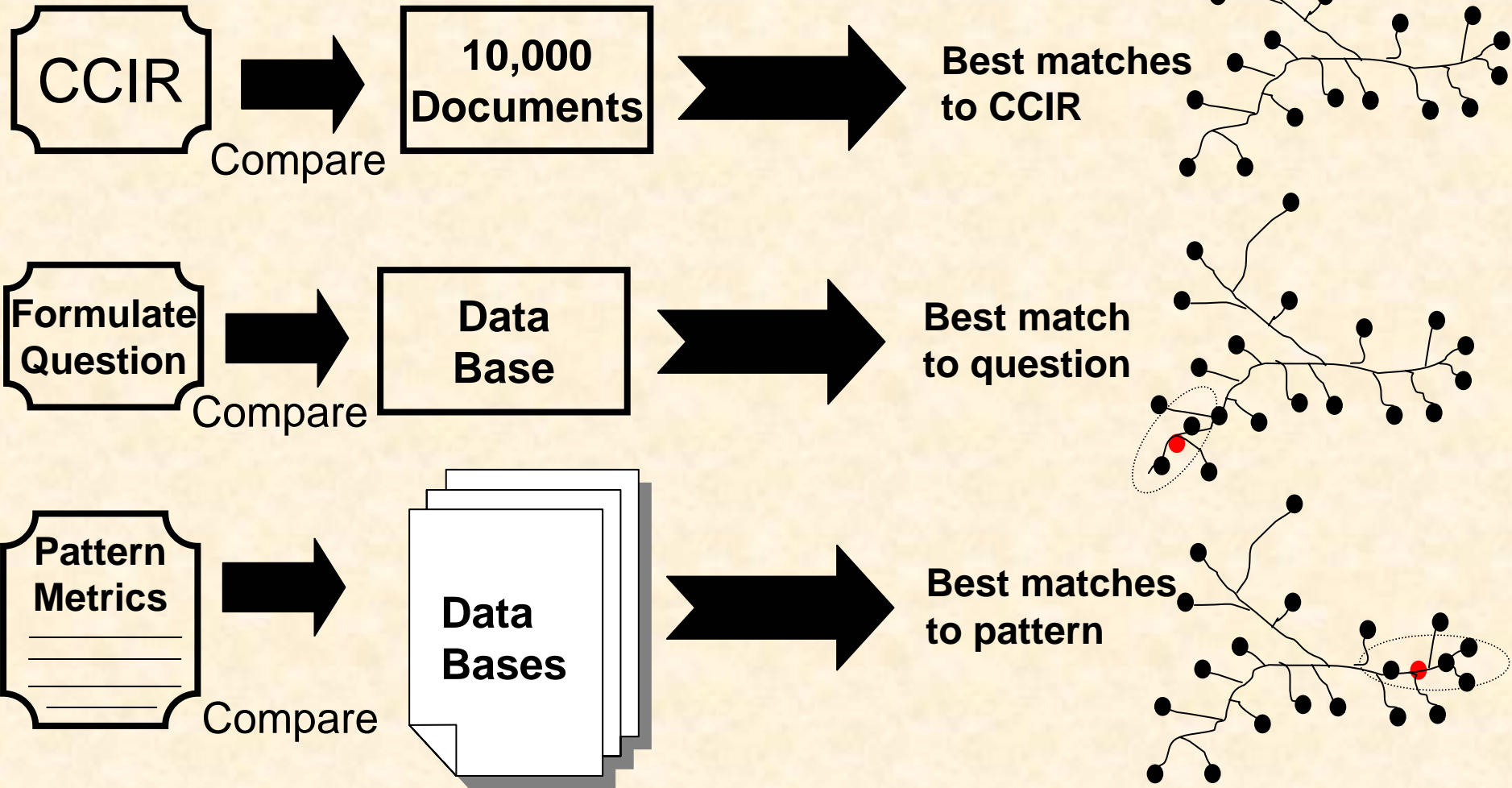
- Agent approach  
**8 minutes 24 Seconds!**

**2000 times faster  
With no loss of  
accuracy**

# Results

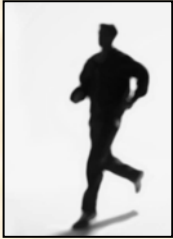


# Software Agent Applications

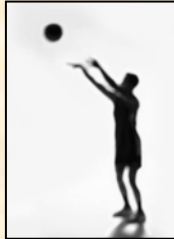


# Next Step: Adding DNA to Agents

Endurance Speed



Agility



Strength



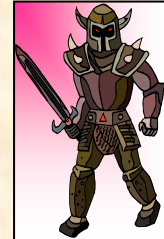
Group



Method



Target



Location



Speed/Strength



Group/Method



Target/Location



Group/Method/Target/Location





# Connecting the Dots

US naturalized citizen indicted for hiding

Cold war leaves a deadly anthrax legacy

6 Indonesians Barred From U.S.  
Current and Former Military Officers



Slevin  
ters



Miller

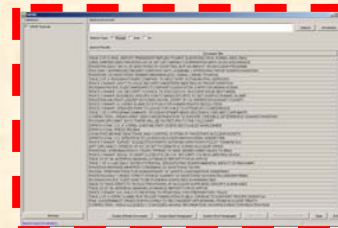
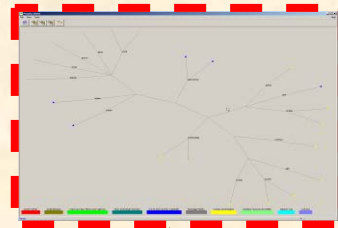


Radiation experts play out a frightening terrorist scenario — exploding a bomb laden with deadly radioactive materials.

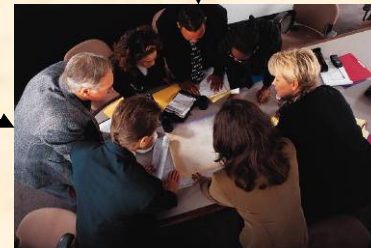
dozen current officers, including on a watch list barring them from entering the United States, according to U.S. government officials.

VOZROZHENIYA ISLAND, Uzbekistan -- In the spring of 1988, germ scientists 850 miles east of Moscow were ordered to undertake their most critical mission.

## OSCAR High Performance Computer Cluster



Synthesizing and Disseminating Information



OAK RIDGE NATIONAL LABORATORY  
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

S

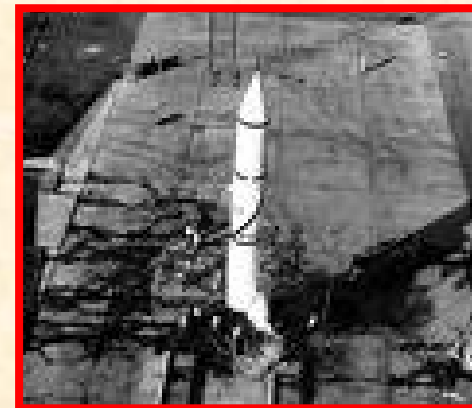
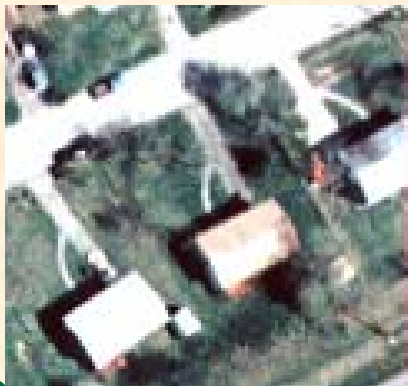
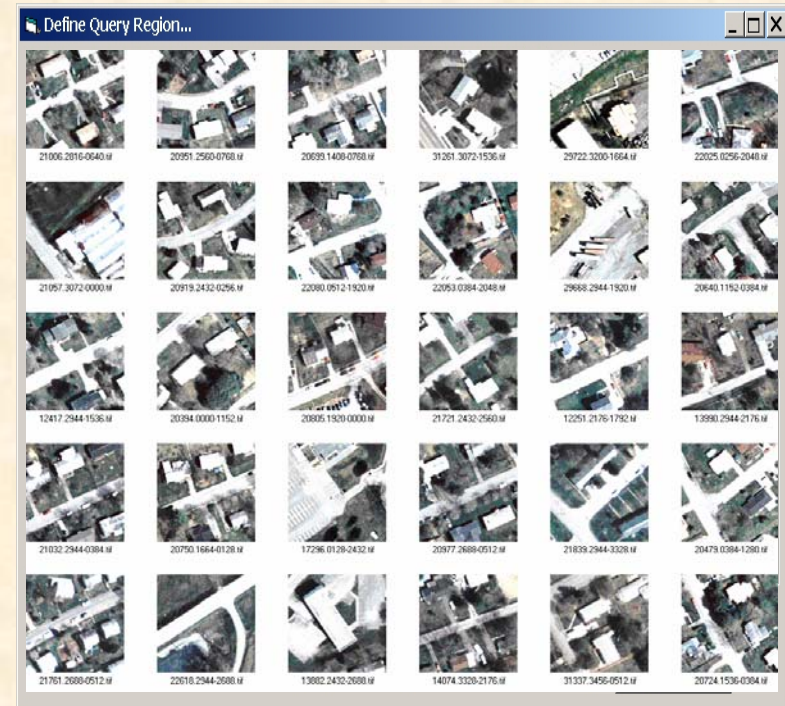
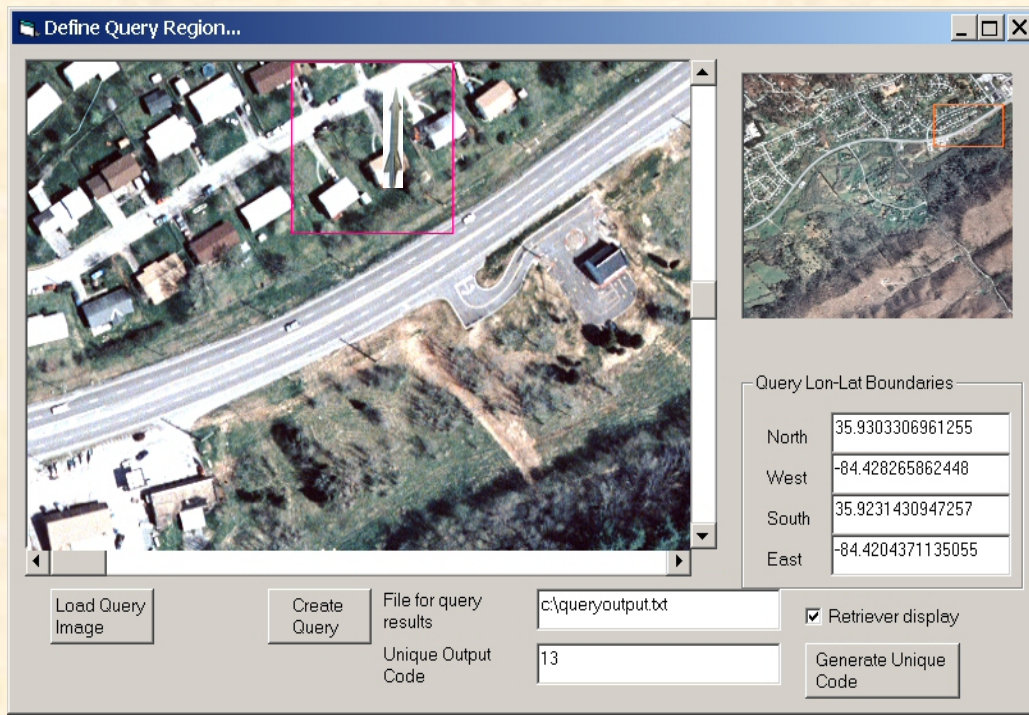
# Screen Satellite Photos at Machine Speed

- Is your image repository up-to-date and accurate?
- How can you search through thousands of images in seconds?
- How can you comprehensively search based on:
  - Longitude and Latitude
  - Box on a map
  - Time
  - “Just like this one”





# Find "Just like this one..."

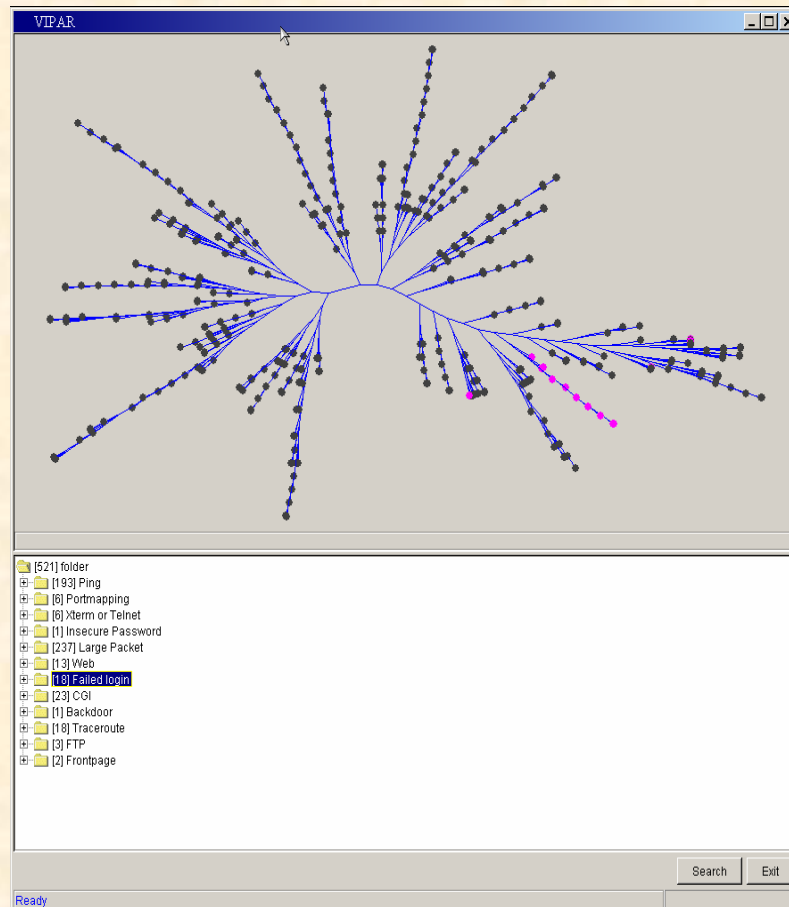
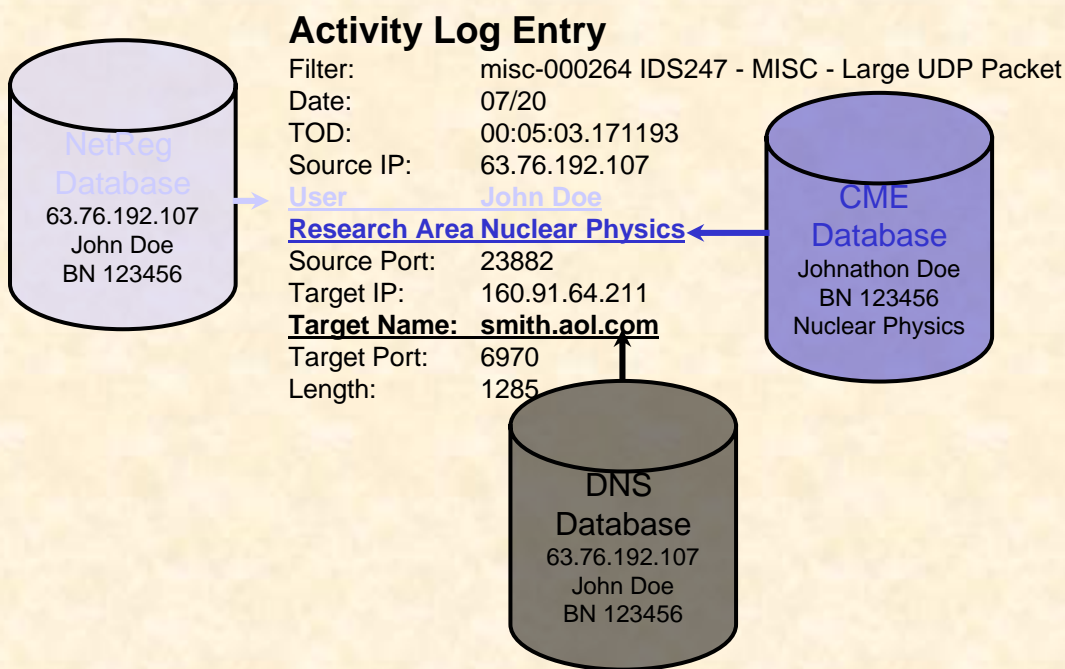


Where is the missile ?

# Cyber Security

## Relate Sensitive Research to IP addresses

- 1,000,000 suspicious records daily
- Critical Decisions
  - Is someone trying to hack into the system?
  - Are attack from “script kiddies” or state sponsored?
  - What are they going after and why?



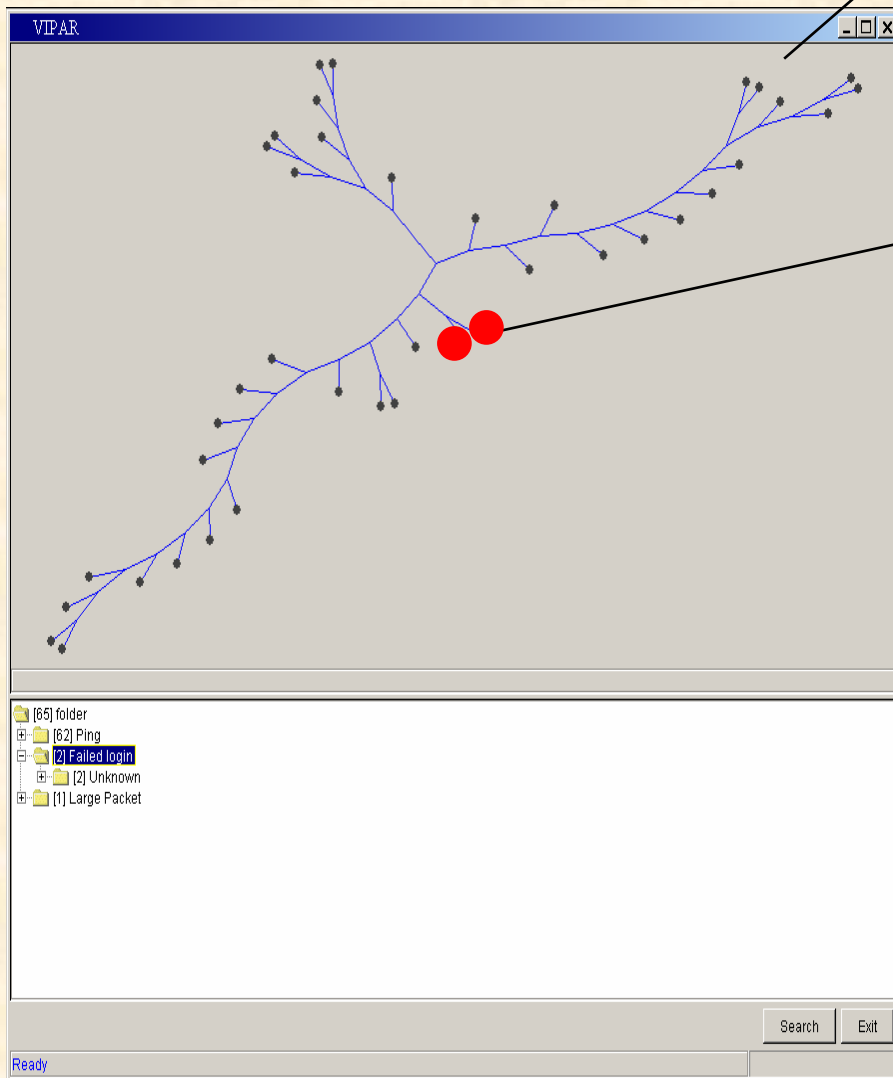


# Caught in 30 Minutes!

45 “low and slow” pings from:

- Country X
- Country Y
- Country Z

2 attacks on nanotechnology scientists



Source IP: 200.10.225.87 ncache07.terra.cl

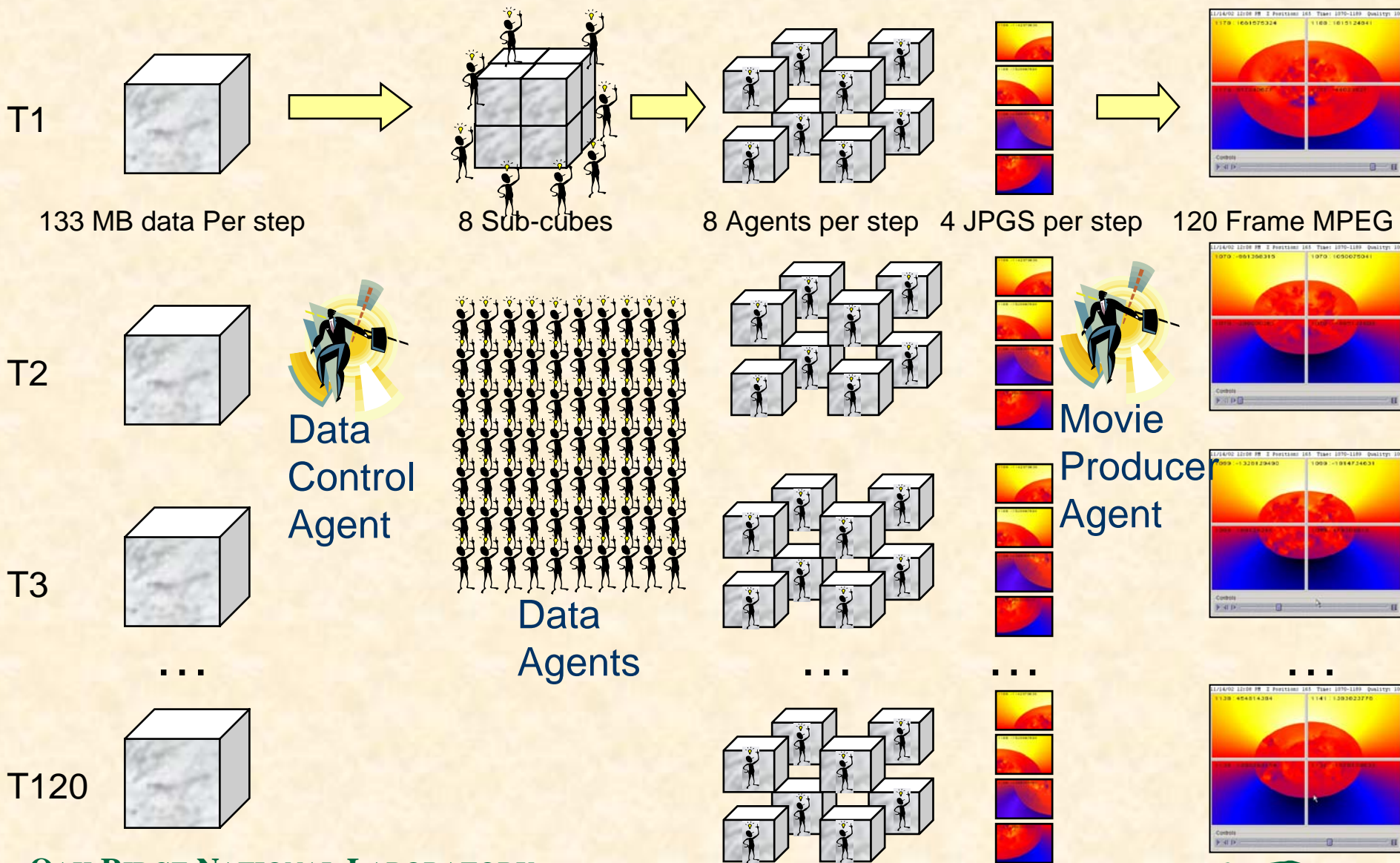
Date	Time	Source Port	Destination IP	Destination Hostname	PI Name	Research Area	Destination Port	Length	Filter
07/23	14:14	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	4145	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	14:29	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	4302	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	14:58	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	4654	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	15:11	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	4768	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	15:31	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	4934	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	16:17	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	1789	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	16:41	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	2130	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	17:00	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	2285	455	Beta-000014 BETA - WEB - 403 Forbidden
07/23	17:27	80	128.219.49.130	LQ32.CT.ORNL.GOV	Hidden	Chemical and Material Science on Nanostructured Surfaces: Biomimetic Photosyn	2575	455	Beta-000014 BETA - WEB - 403 Forbidden

Patent Pending

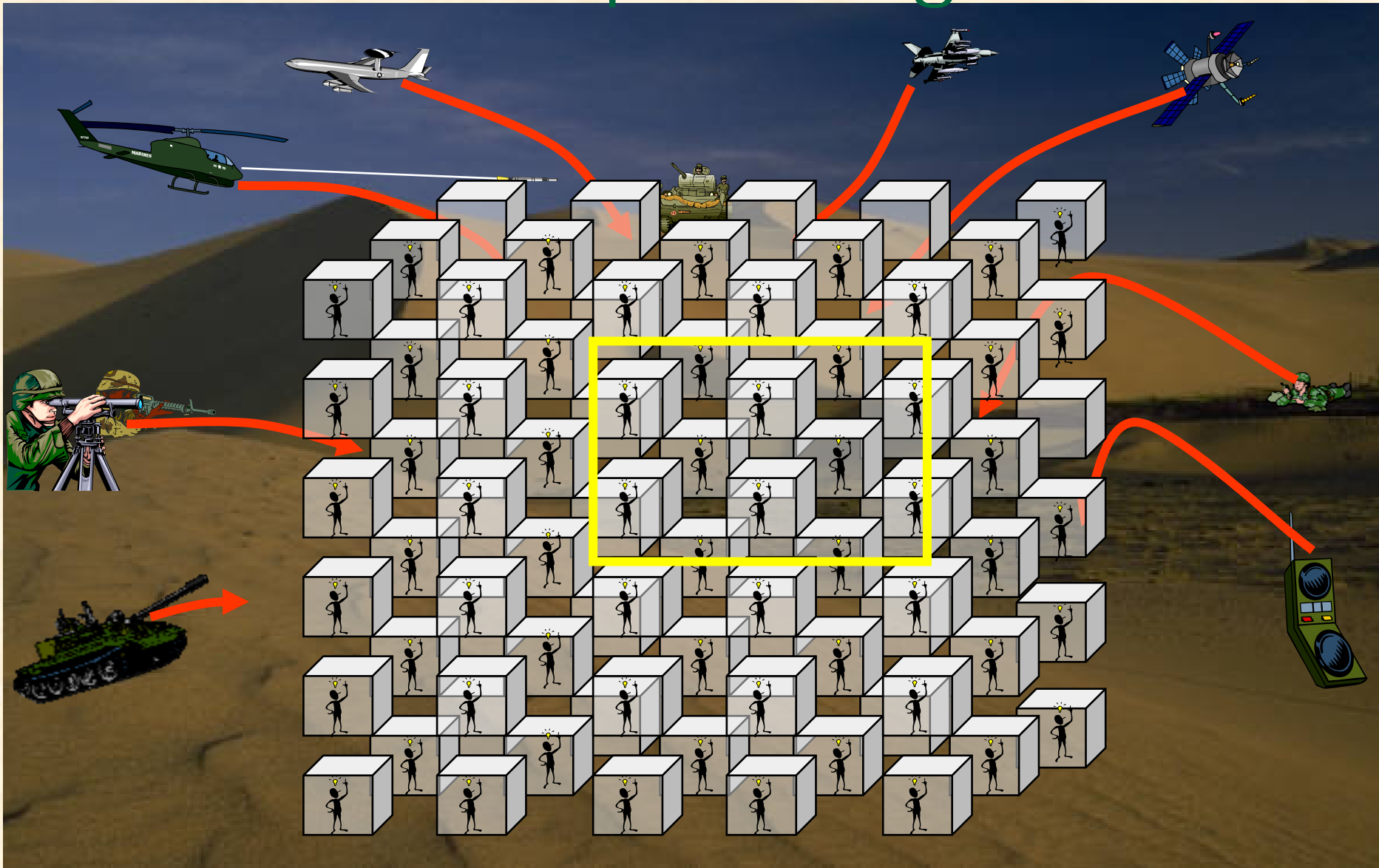
# Agent Example "Pictures from Data"

- 1 Terabyte of streaming astrophysics data
- 1000 agents analyzing
  - 120 time steps of 300x300x300 matrix for 5 variables
  - 33 million units density in 194 files
- Each time step governed by an oversight agent which redraws picture with most recent information

# Astrophysics Common Operational Picture

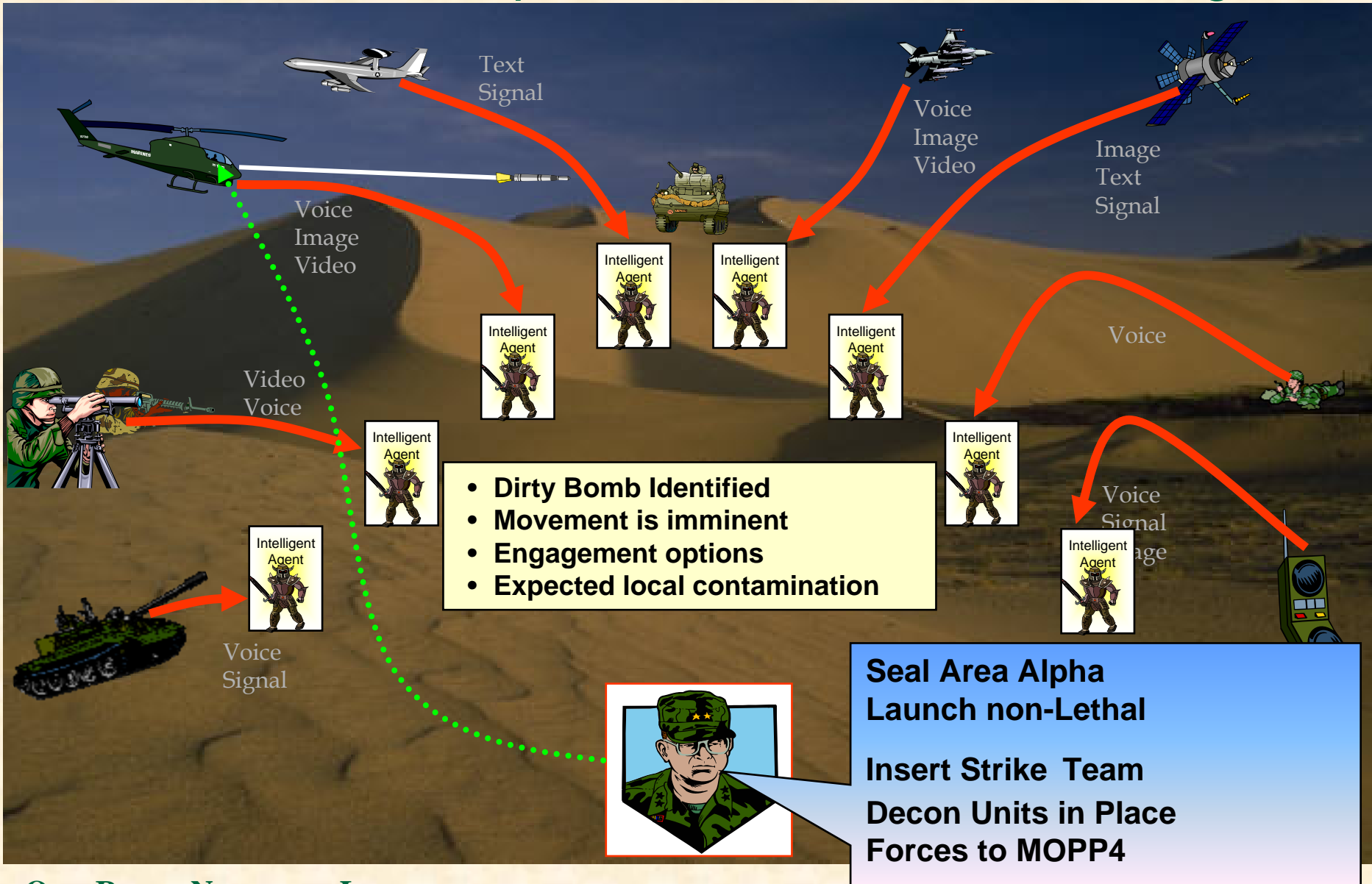


# Common Operating Picture





# Future Battlespace – Forward Analysis



# Knowledge Discovery

"The Art of the Possible"



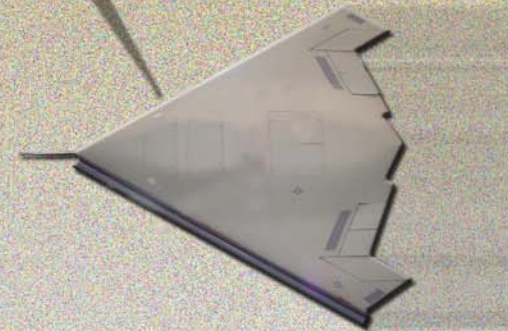
**OAK RIDGE NATIONAL LABORATORY**  
**U. S. DEPARTMENT OF ENERGY**







**Sqdn Cdr**



#### Info Transmitted

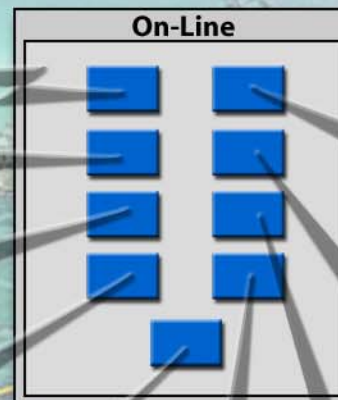
Engine (MTBF)  
Transmission (MTBF)  
Weapon System (MTBF)  
Ammo  
Fuel

#### END ITEMS

Fixed Wing Attack  
Fixed Wing Non-Attack  
UAV (Attack)  
UAV (Intel)  
Ground Support  
Equipment













**Warning  
Order  
at 1200 Z**



**JFC J3**



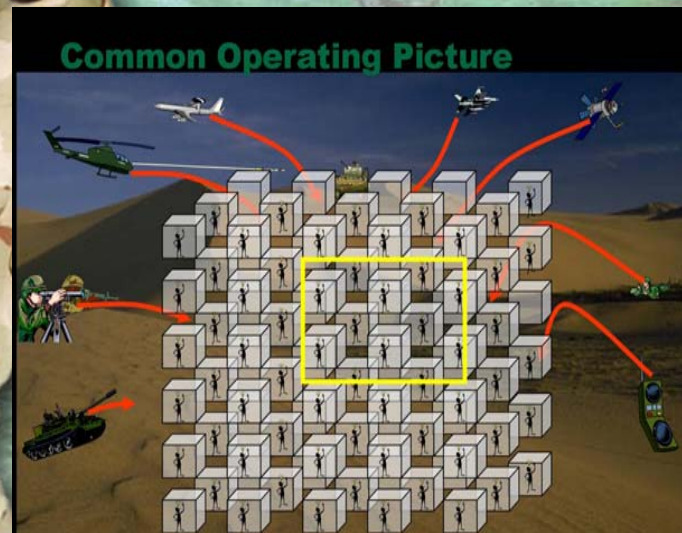
Units Available		Deployment List
		ACC
		MC
		AF
		SOC
		NAV

UID  
 Readiness  
 Load Plans  
 Movement Requests  
 Movement Plans  
 Support Slice  
 Sustainment

On-Line	
ACC	DLA
AFCC	NCC
USMCCC	DOD
SOCC	J5J3
TRANSCOM	UID

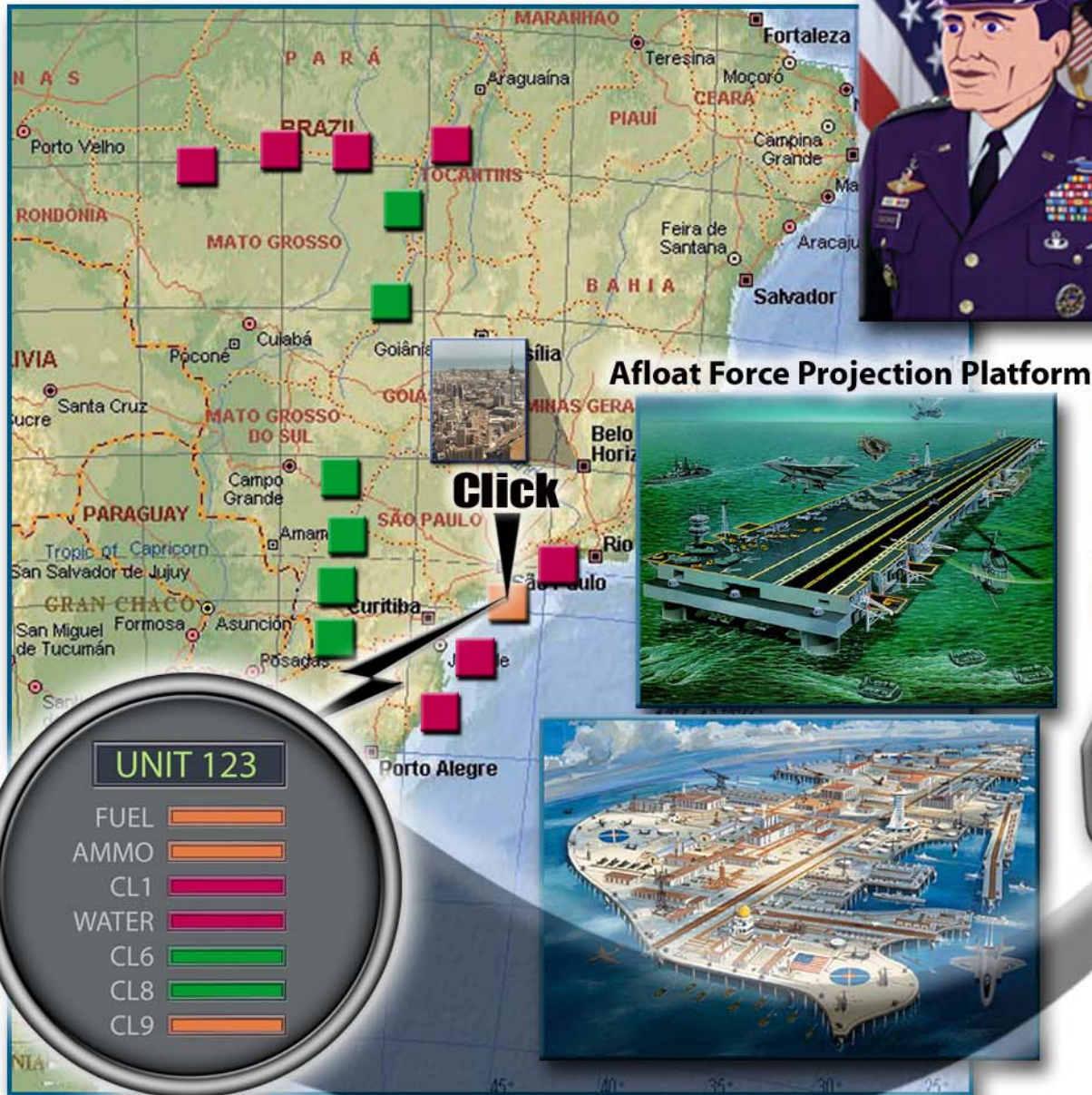
Given the theater capabilities  
 the JFC requires—what forces  
 can you contribute to the JF?

Net Order
Situation
Mission
Concept
Focus
Log/Support
C2
Courses of Action





# Day 5: Combat Power



Afloat Force Projection Platform



# Path to Success

- **Vision the Capability**
- **Articulate the Development Path and Priority**
- **Leverage the niche Centers of Excellence**



# Knowledge Discovery 2020



**Know all that can be known  
Apply the Power of the Force**

**“The Force Is Always With You”**



# **Solutions to Current Challenges: FY07-FY09**

**Major General Ted Bowlds**

**4 April 2007**





# AFRL Vision



## Air Force S&T Vision

Anticipate, Find, Fix, Track, Target, Engage,  
Assess, Anything, Anywhere, Anytime



## AFMC Vision

War-winning  
Capabilities...  
On Time, On Cost

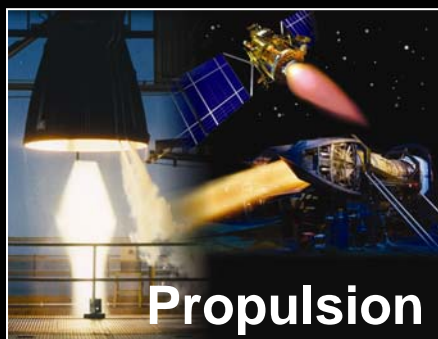
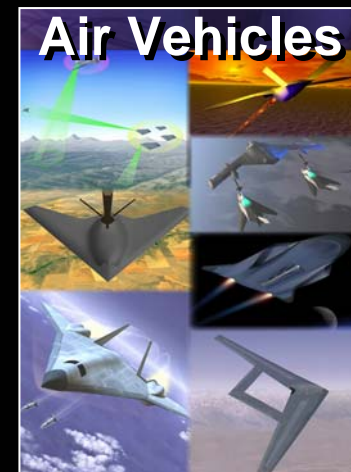
## AFRL Vision

We **defend** America by  
unleashing the power of  
innovative science and  
technology





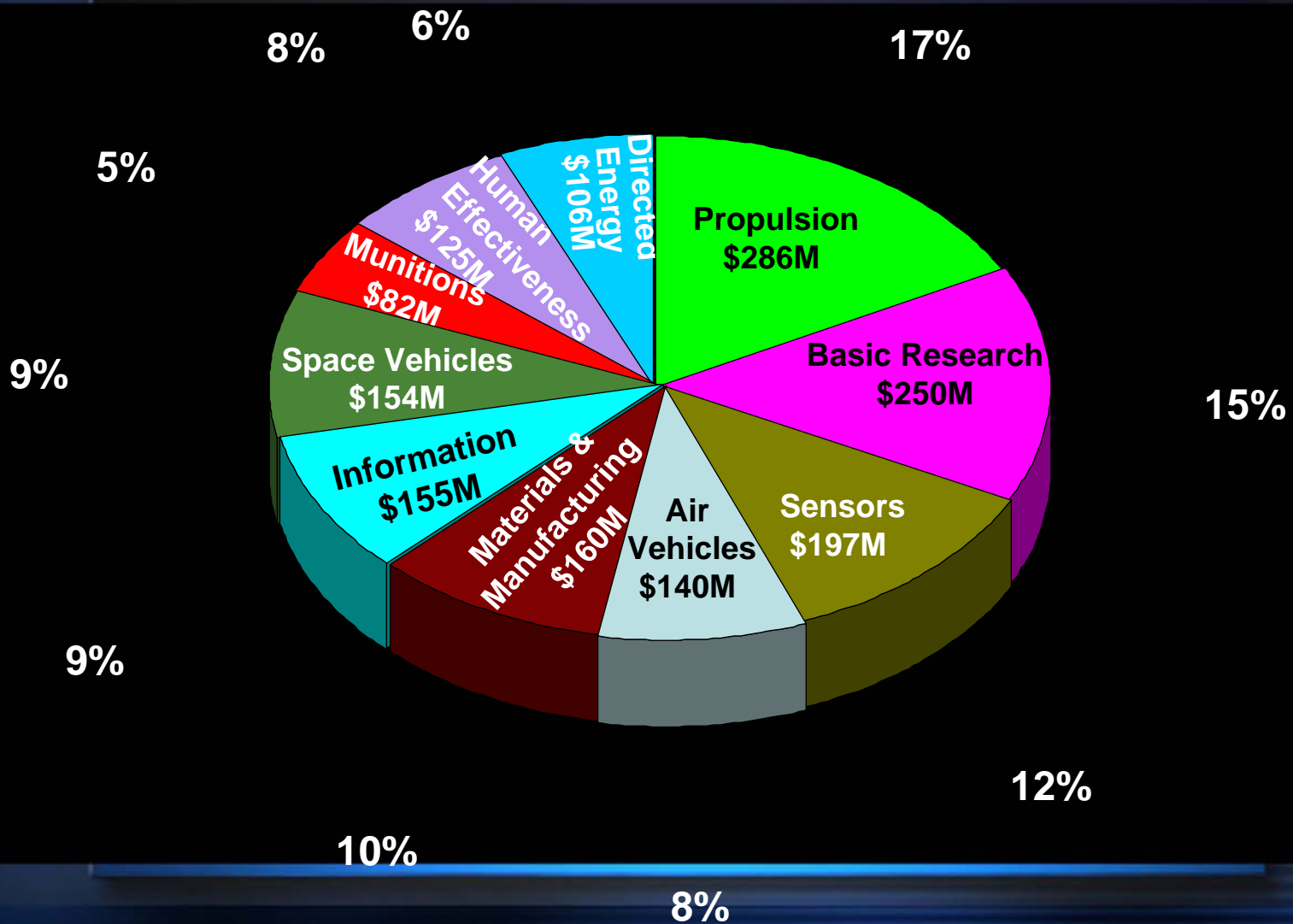
# Core Work Areas







# AF Budget Investment By Tech Area



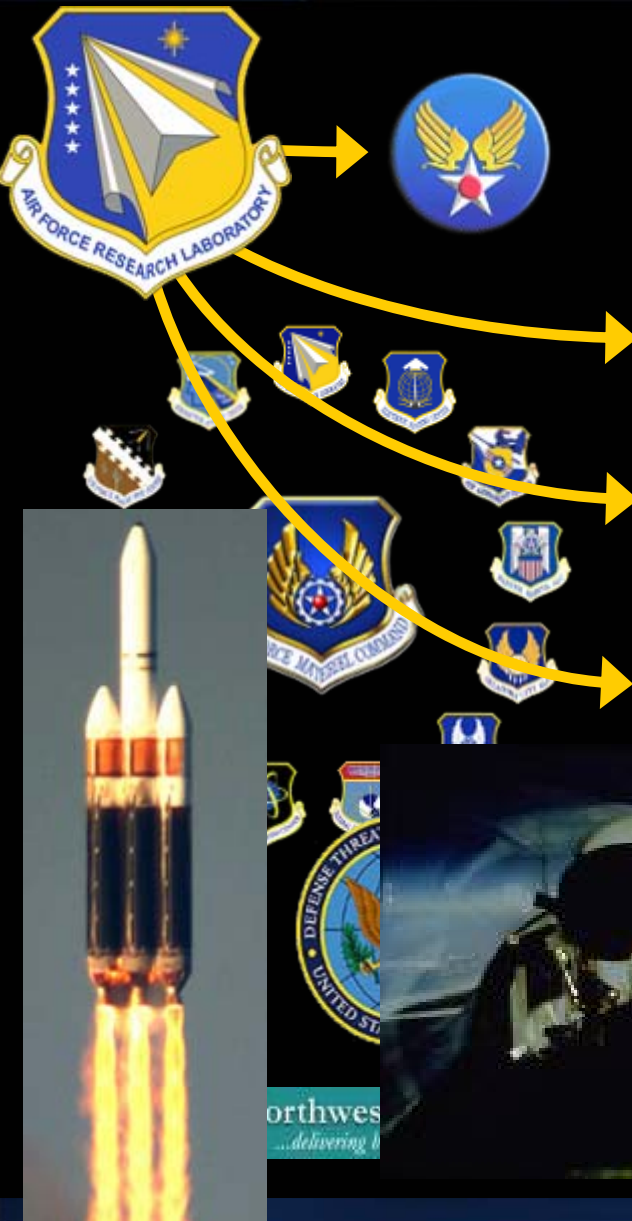
*AIR* *SPACE* *CYBERSPACE*

FY07 Presidential Budget  
Values May Not Add Due to Rounding





# AFRL Customers



## AF Senior Leadership

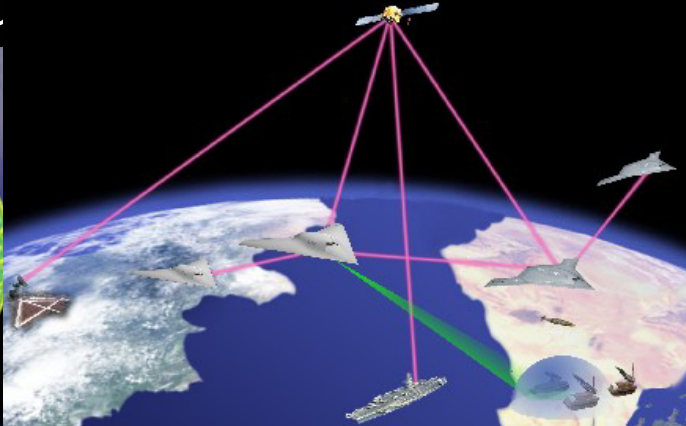
- Top-level guidance and strategy

## Program Managers (Capability Developers)

- Anticipate, Find, Fix, Track, Target, Engage, Warfighter
- Core S&I connected per needs

- Solve capability gaps and shape future concepts
- AFRL pushes to show operators what's possible

niql





# AFRL's Core Processes Aligned with Customer Needs

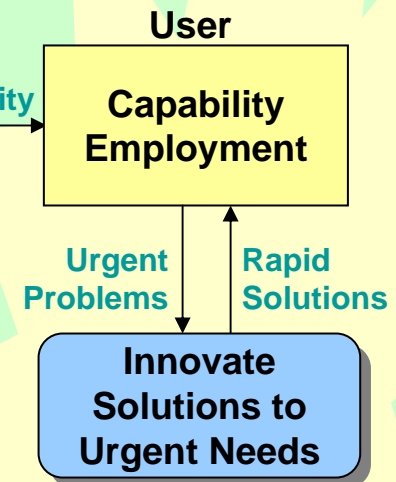
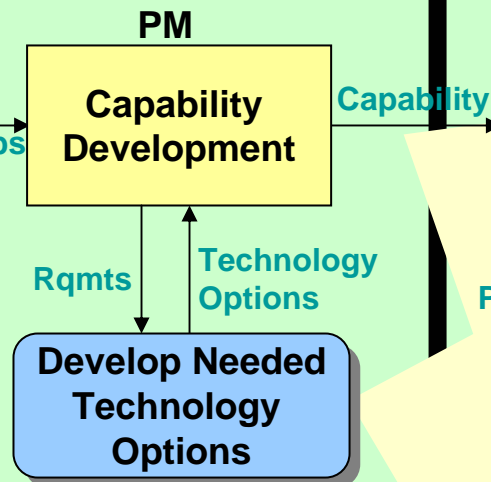
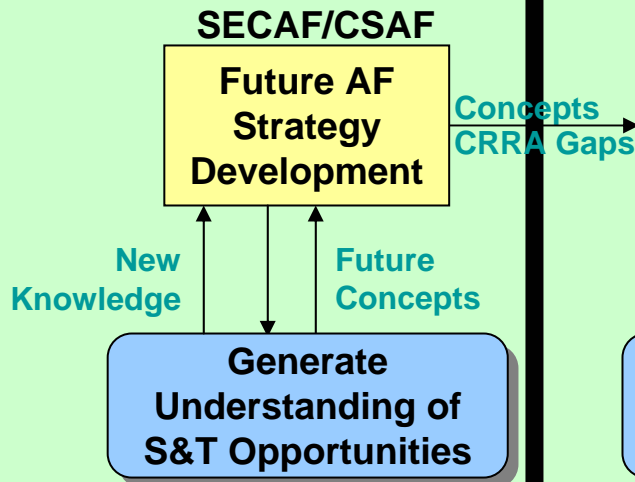


Needs

Future Transformational  
Warfighting Systems

Timely Technology  
Insertion into Systems

Problem Solving and  
Adaptation of Systems



Values

Invention  
Vision / Communication  
Technical Depth

System Engineering  
Due diligence  
Delivery on time

Innovation  
Rapid response  
Trans-disciplinary

Core Process 1

Core Process 2

Core Process 3

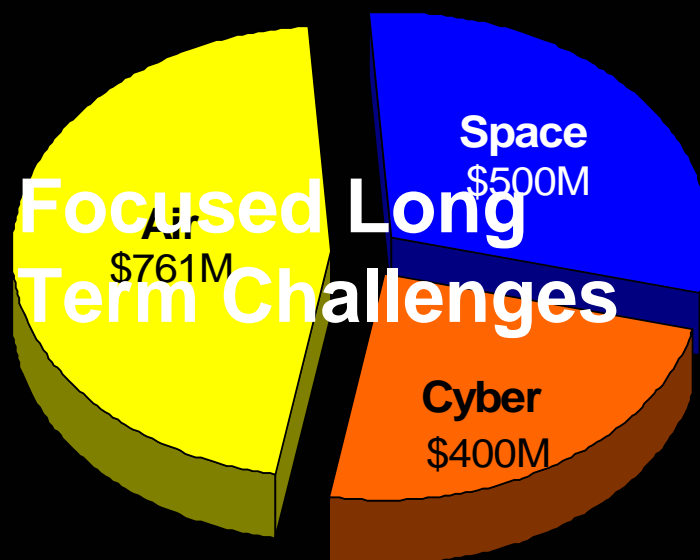
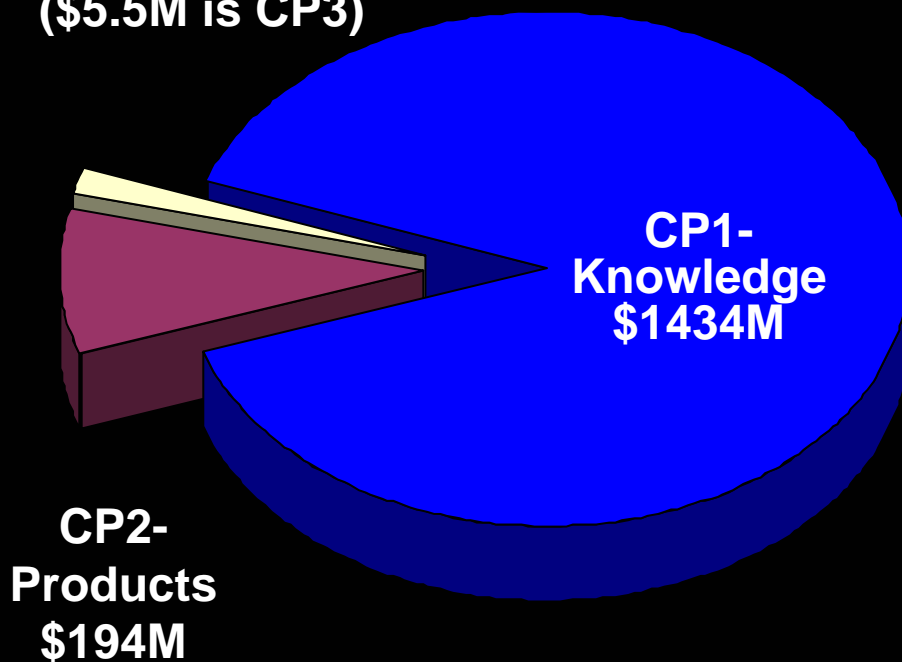


# FY07 \$ in FY07 PB

## By Area



**\$27M-Recent support\***  
(\$5.5M is CP3)



**Focused Long  
Term Challenges**

**TOTAL: \$1.655 Billion**

*AIR* \* Delivered to supporting current on-going combat operations

*SPACE*

*CYBERSPACE*



# Core Process 1

## Focused Long Term Challenges



Focus on long-term challenges (problems) to

- Defined by the end user problem statements

Anticipate, Find, Fix, Track, Target, Engage,

Associate, **FLTC #1** Anything, Anywhere, Anytime

**AF<sup>2</sup>T<sup>2</sup>EA<sup>4</sup>**



FLTC #2

FLTC #3

FLTC #4

FLTC #5

FLTC #6

FLTC #7

FLTC #8

Problem #1

Problem #2

Problem #3

Problem #4



Program

Program

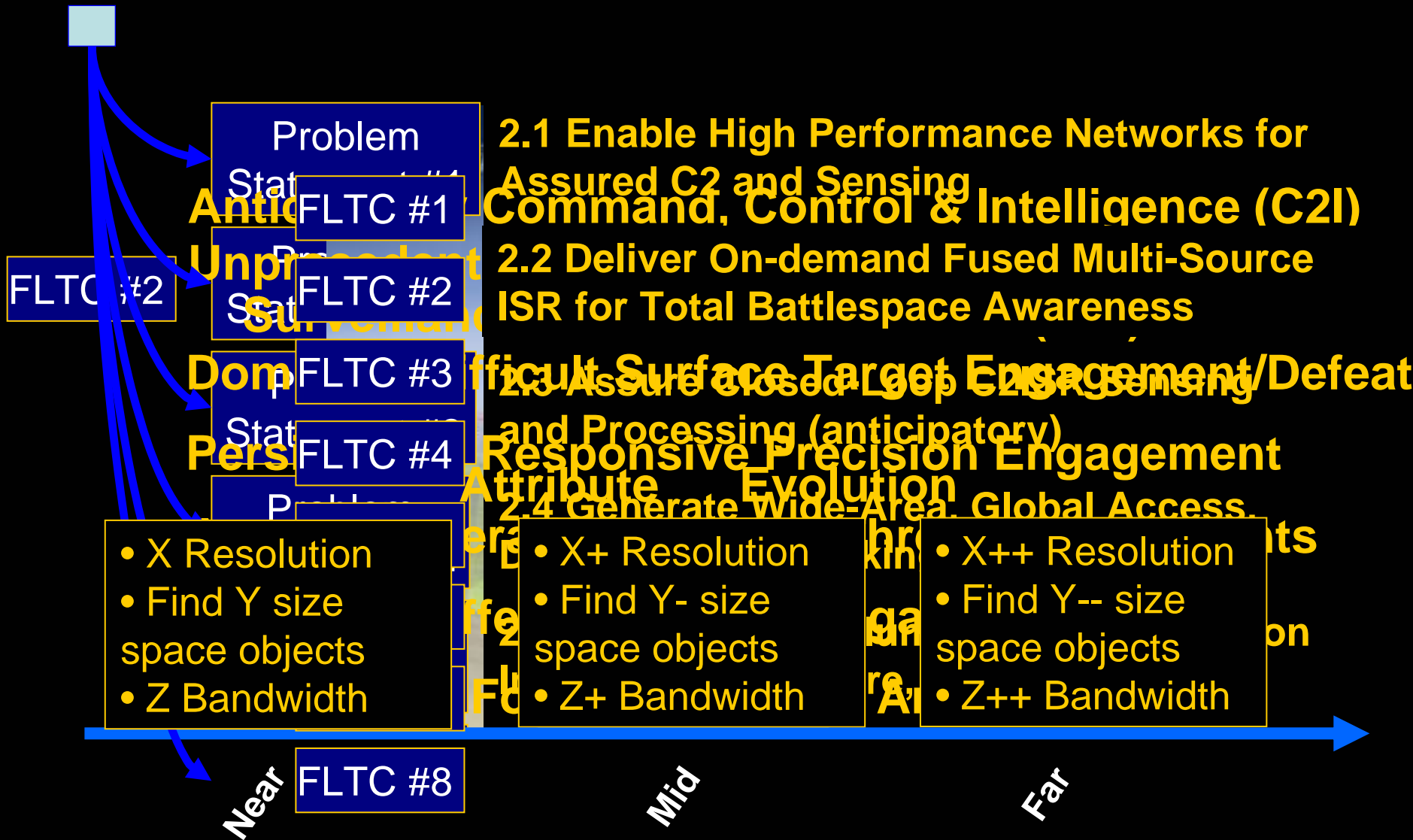
Program

**Many AFRL programs tied directly to the user's problems**





# FLTCs – Examined





# FLTCs – Examined

## Unprecedented Proactive Intelligence, Surveillance, and Reconnaissance (ISR)

FLTC #2

Problem Statement #2

2.2 Deliver On-demand Fused Multi-Source ISR for Total Battlespace Awareness

Mid-Term Attribute 2.2.1

Survivable, High-altitude, Long Endurance, Multi-INT Sensing for Battlespace Awareness

Product 2.2.1.1 Improved Light Aircraft Structures (VA)

Product 2.2.1.2 Structurally Integrated Aircraft Antennas (VA)

Product 2.2.1.3 Internally Funded Program

TRL MRL

Partially or Un-Funded Program

TRL MRL

Product 2.2.1.4 Jointly Funded Program

TRL MRL

Externally Funded Program

TRL MRL

TRL

Technology Readiness Level

MRL

Manufacture Readiness Level



# Socialization Process to Date



- 20 Jun 06 ACC/A8 and ACC Staff
- 21 Jun 06 AFSPC/A3 and AFSPC Staff
- 26 Jun 06 AFSOC/A8/A5 and AFSOC Staff
- 27 Jun 06 AFFTC Staff
- 28 Jun 06 AETC/A5/A8 and AETC Staff
- 14 Jul 06 SMC/CC
- 20 Jul 06 AFC2ISRC/A8 and AFC2ISRC Staff
- 25 Jul 06 ESC
- 28 Jul 06 AMC/A5 and AMC Staff
- 3 Aug 06 DTRA
- 7 Aug 06 Air Staff – A3, A8, AQR
- 30 Aug 06 NSSO S&T IPT
- 30 Aug 06 Air War College
- 31 Aug 06 AFSPC/CC
- 1 Sep 06 AF SAB
- 5 Sep 06 PACOM
- 7 Sep 06 ONR
- 11 Sep 06 N-81 Study Team
- 21 Sep 06 AFSPC



# Socialization Process to Date



- 25 Sep 06      NAVAIR Process Council
- 28 Sep 06      AFSOC
- 5 Oct 06       Dir NASA Dryden
- 5 Oct 06       AFRL-AFIT Summit
- 6 Oct 06       AFSPC/CV Brief
- 19 Oct 06      DTRA
- 14 Nov 06      USSOCOM
- 30 Nov 06      ACC/AFC2ISRC
- 8 Dec 06       NASA HQs
- 19 Dec 06      ASC/XR
- 3 Jan 07       SAF/AQ
- 3 Jan 07       DDR&E
- 9 – 11 Jan 07   Deep Dive Workshop #1 – DC
- 17 Jan 07      Cyber Command
- 31 Jan 07      Dr Erbsloe, AMC/ST
- 5 Feb 07       ASC Aeronautical Enterprise IPT
- 7 – 8 Mar 07   Oak Ridge National Lab
- 8 Mar 07       Idaho National Lab
- 14 Mar 07      NGA



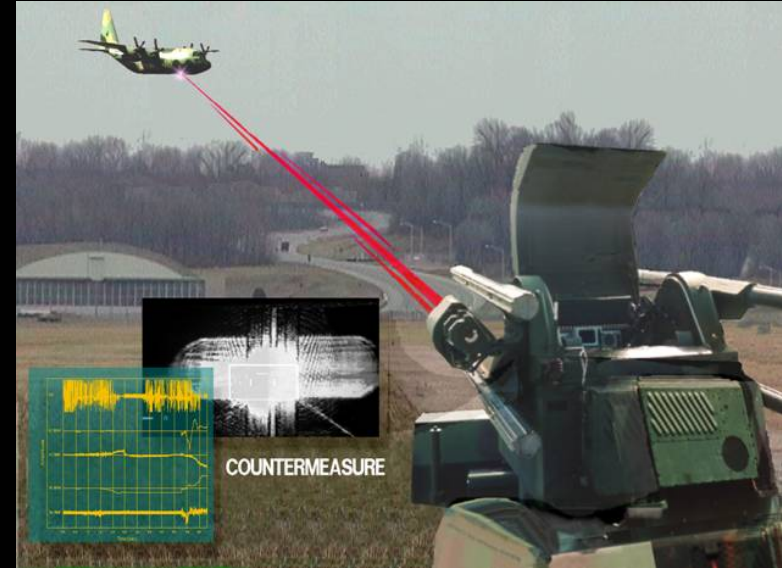


# Technology Insertion

## Day/Night EO/IR Tracker CM



- Locates and defeats / denies use of passive infrared fire control systems and active laser trackers on man-portable and mobile SAM systems
  - Compatible with AFSOC/SOCOM platforms using DIRCM IR CM systems
- Detects threat IR sensors before weapon launch
- Provides threat location and possible threat classification
- Provides option to avoid, deny or counter the threat beyond missile launch range
- Denies enemy the ability to operate passively (forces RF use) and increases survivability
- Negates AAA and laser beam rider tracking



NWIR & LWIR Lasers

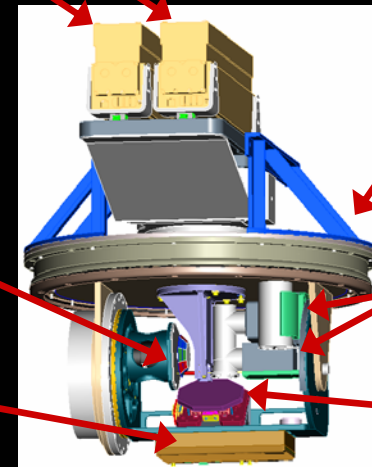
Polygon Mirror

Receiver Electronics

Azimuth Platter

LWIR & NWIR Receivers

Fine Steering Mirror







# BAO BRITES ATD SPIRAL 2



(PM – Lt. Josh Johnson, AFRL/PR)

Methanol Fuel Cells  
~500 W-hr/kg

Solid Oxide Fuel Cell  
~600 W-hr/kg



Zinc Air  
~350 W-hr/kg



Optimized Li Ion  
~200 W-hr/kg



Rechargeable  
Li Metal  
~300 W-hr/kg

Lithium Ion  
~200 W-hr/kg



Spiral 3  
50%

Spiral 2

33% Wgt Savings

Spiral 1  
25%

Power  
Management

High Power

High Energy







# Technology Insertion

## Trusted Tactical Weaponneering for Cyberspace

(PM – Rick Metzger, AFRL/IF)



### ➤ Program objectives

- Combines disparate cyber programs throughout the AF and Intelligence community
- Enhance C2 with remote cyberspace attack capabilities
  - Third leg of “C2 Triad”



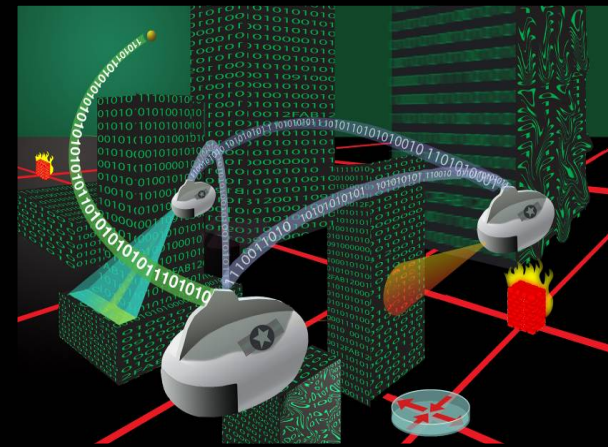
### ➤ Benefits to the Warfighter

- Enables warfighter to dominate the cyberspace: strike anytime, anywhere
- Global reach: unprecedented access beyond physical and geo-political boundaries.
- Gathers intelligence for IPB
- Acts as non-traditional ISR asset: supports BDA



### ➤ Schedule

- Contract (Jan 06)
- Demo (Sep 09)



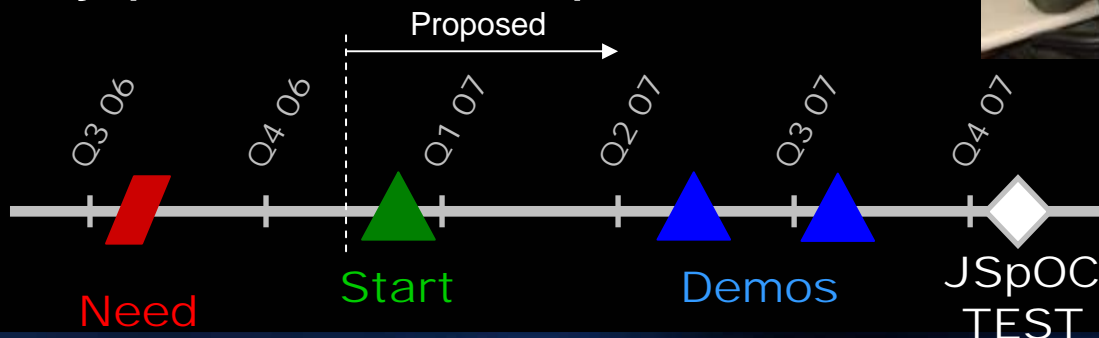
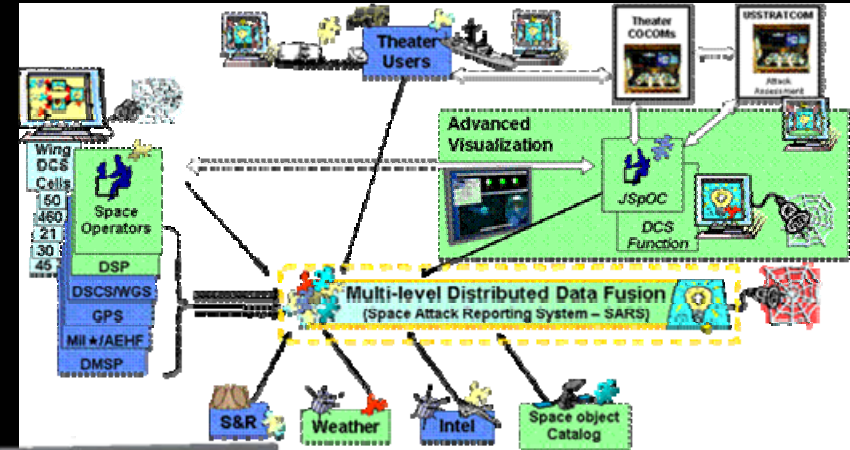




# AFRL Rapid Reaction Project Space Situation Awareness



- **Commander Joint Space Operations Urgent Need**
  - Rapid ability to assess space situation using existing information
- **70% Quick-to-Field Solution Identified**
  - Data fusion and intuitive display of telemetry, ephemeris, and space weather data
  - Plan to validate in Joint Space Operations Center (JSpOC)
- **Coordinating plan with broader community (AFSPC, SMC, etc)**



**Rapid  
Response**

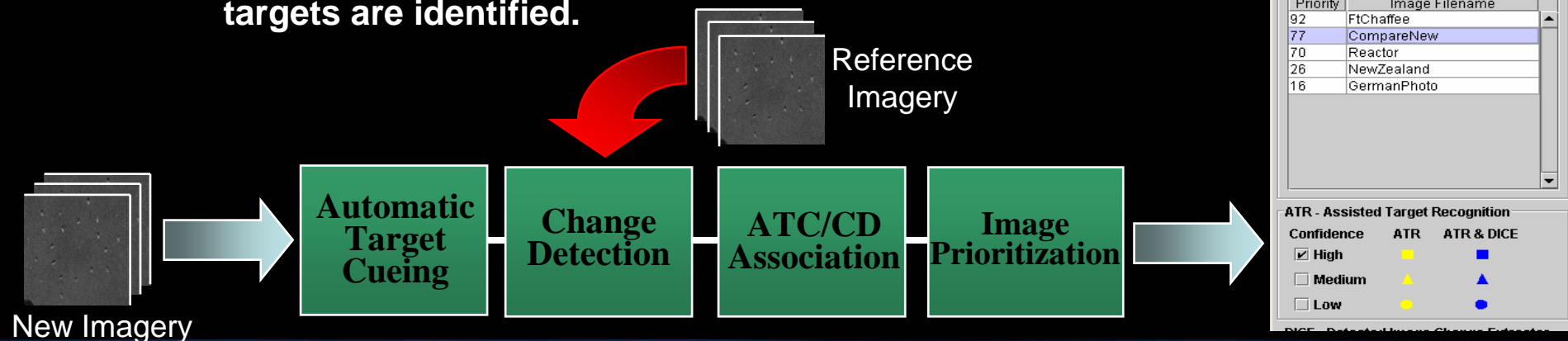
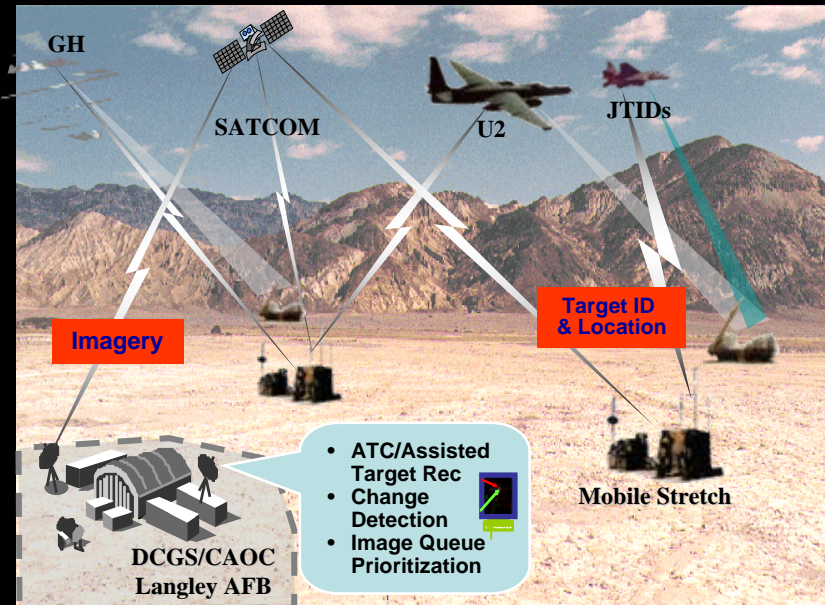


# Assisted Target Recognition for Time Critical Targeting

(PM – Lt. Amanda Martin, AFRL/SN)



- Dynamic high value targets are only vulnerable for short periods of time
- Image Analysts are responsible for ever increasing, large volumes of data
- **Solution**
  - Automatic Target Cueing (ATC)
    - Automatic Target Detection
    - Assisted Target Recognition
  - Change Detection (CD)
    - Compares images collected at different times to identify change.
  - Image Prioritization.
    - Sources of information are correlated and images are most likely to contain targets are identified.

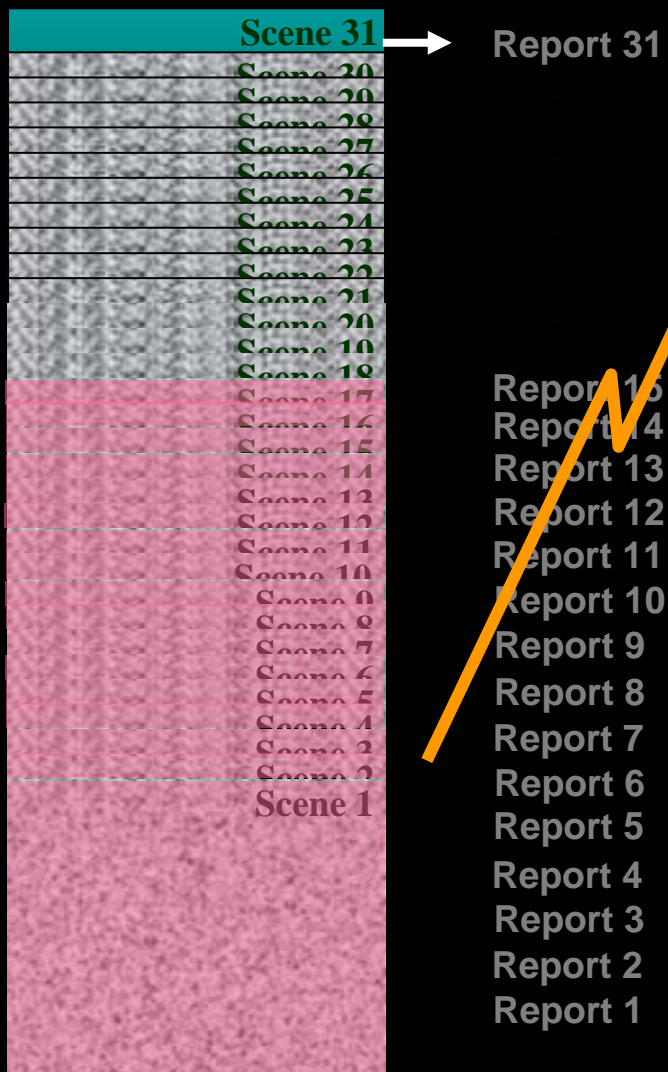




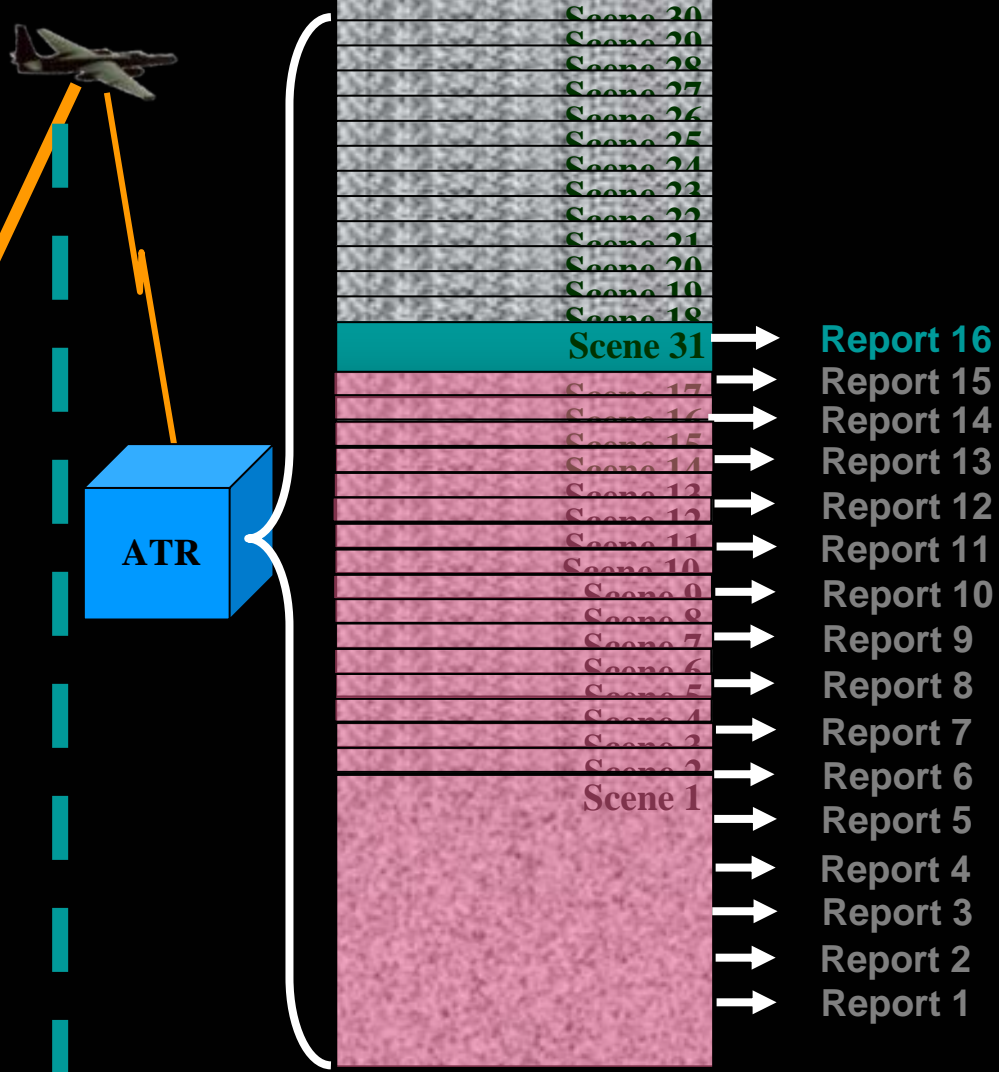
# Potential ATR Uses – Shorten Timelines



## Current Process



## Exploitation Queue Prioritization








# Key Observations



- Collaboration a must
- Direct warfighter-scientist interaction essential
- Put high risk efforts in lab, not in programs



A graphic of a globe composed of a grid of dots, rendered in a lighter blue color, positioned behind the AFRL text.

# AFRL

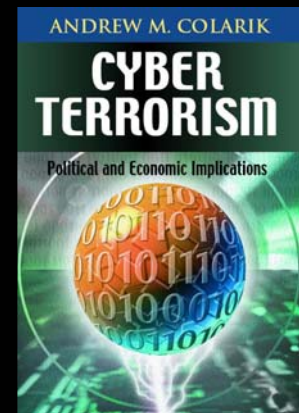
THE AIR FORCE RESEARCH LABORATORY  
LEAD | DISCOVER | DEVELOP | DELIVER



# AFRL Rapid Reaction Project Cyberspace



- Addressing urgent needs for MAJCOMs (PACOM) and soon to be:
  - Cyber Command
  - ISR Command
- Understanding the urgency for rapid action within the cyber arena
  - Access, stealth and persistence
  - Cyber tracking technology
  - BDA/IPB
  - PSYOPS
  - Cybercraft
  - Anticipatory modeling of human behavior
- Identified CP3 projects
  - Information Support Server Environment Guard
  - Web Enabled Timeline Analysis
  - DODIIS Trusted Workstation
  - Joint Targeting Toolkit







# Core Process Alignment with Customer Timelines and Needs



**SECAF, Chief – long view, strategic planning**



**PM, Industry/Product Center – next generation, acquisition timelines**



**Warfighter – day-to-day, employing capabilities**

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

**rapidly deliver technical innovation, driven by warfighter emergencies – reshape today's battles**

Core Process 3

**CP3**

**develop technology options that meet the needs of capability developers – shape today's Air Force**

Core Process 2

**CP2**

**conduct long-term research, driven by a bold technology goal – shape the future Air Force**

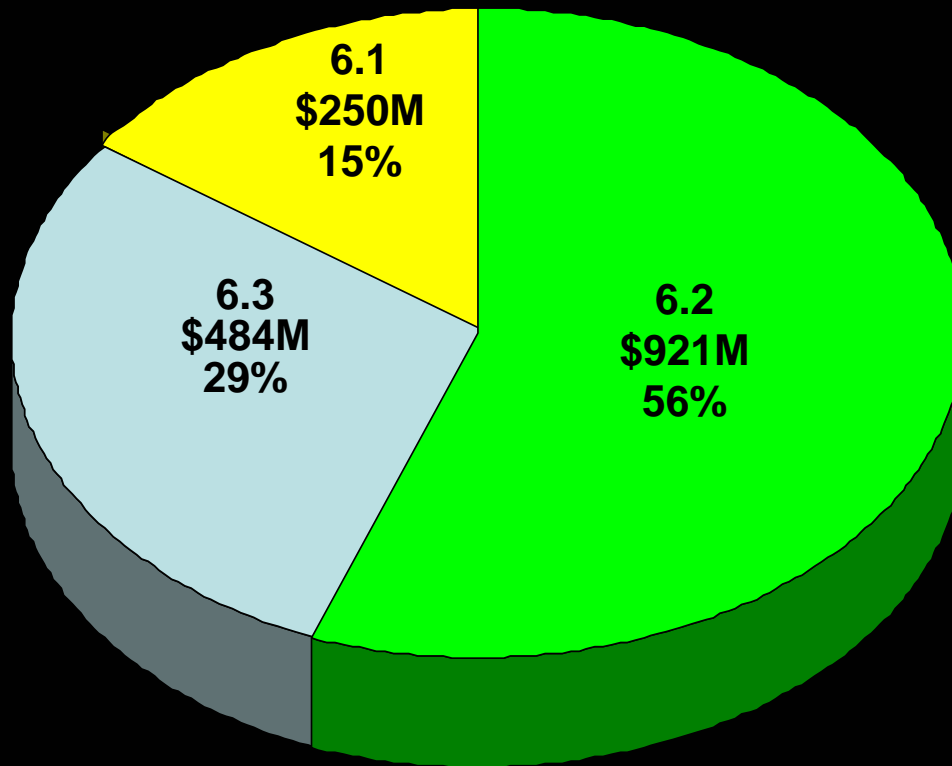
Core Process 1

**CP1**





# AF Budget Investment By Budget Activity



**TOTAL: \$1.655 Billion**

*AIR*

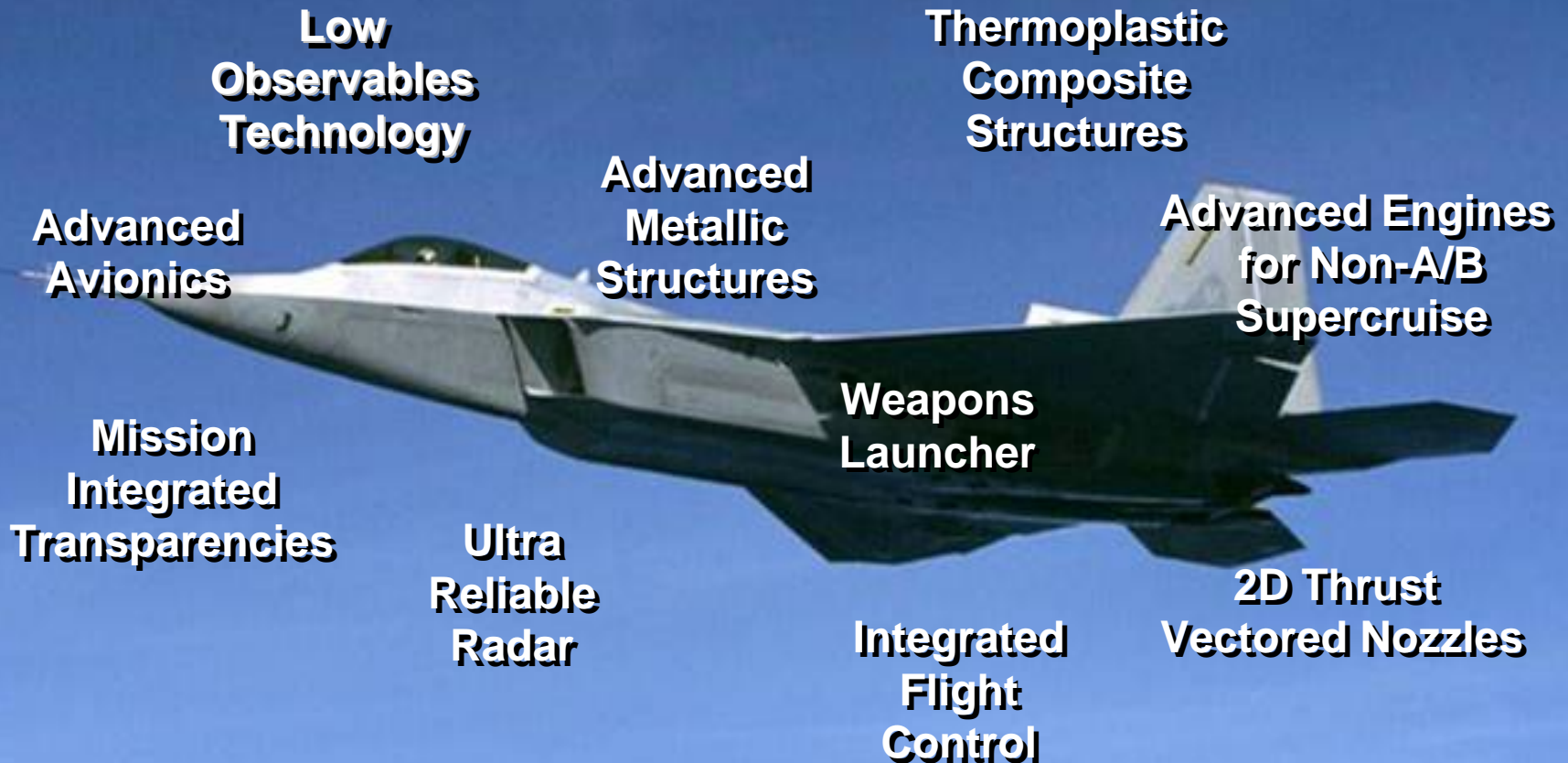
*SPACE*

*CYBERSPACE*





# AFRL Technology Transitions to F/A-22



**\$900M S&T Investment in 1970s - 1990s**



# AFRL Technology Transitions to F-35



*AIR*

*SPACE*

*CYBERSPACE*





# AFRL Technology Transitions to UAVs



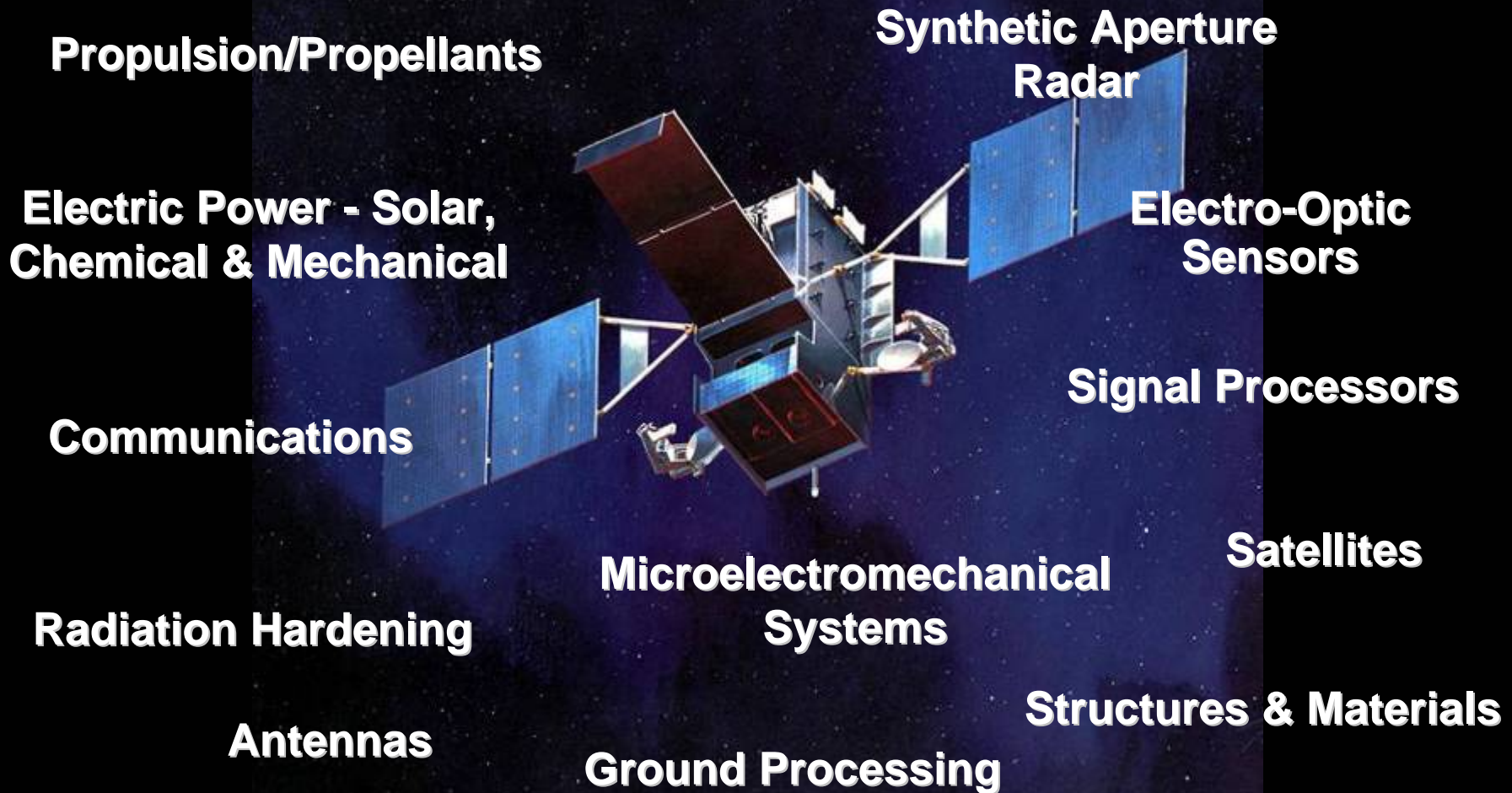
AIR

SPACE

CYBERSPACE



# AFRL Technology Transitions to Space



*AIR*

*SPACE*

*CYBERSPACE*





# AFRL Information Technology Transitions



*AIR*

*SPACE*

*CYBERSPACE*



# AFRL Technology Transitions to Munitions



**GPS/INS Guidance Solutions**

**IMU Miniaturization**

**& Cost Reduction**

**Smart &**

**Survivable Fuzes**

**Compressed**

**Tail Kits**

**Anti-Jam  
Technologies**

**Compact, Extended Range Wing Kits**

**Enhanced Blast  
Explosives**

**Miniaturized  
Fuzes**

**Lethality/  
Vulnerability  
Modeling**

**Component Test  
& Analysis**

**High Fidelity  
Design Tools**

**Optimized W/H  
Geometry  
for Penetration**

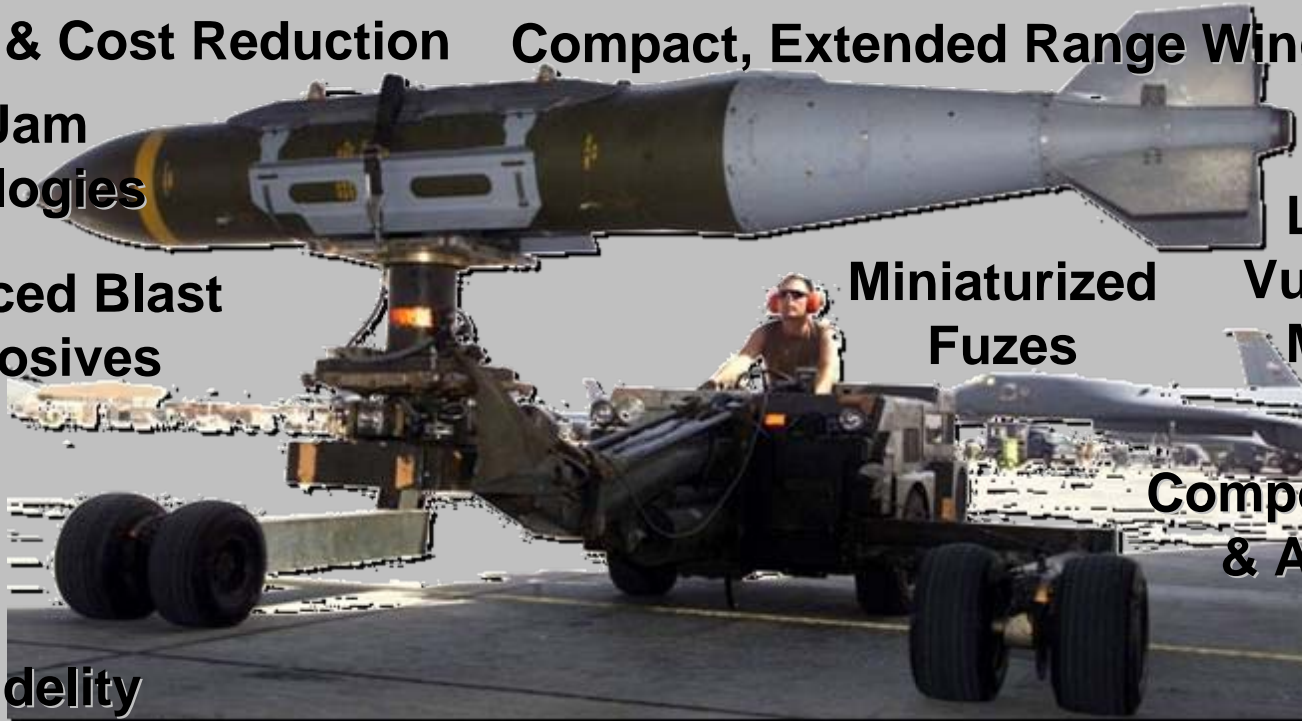
**System Demonstrations  
Insensitive Munitions**

**High Strength  
Warhead Cases**

*AIR*

*SPACE*

*CYBERSPACE*







# AFRL Technologies Support Operation Iraqi Freedom



- Battlefield Air Operations Kit
- Anti-Jam GPS
- Massive Ordnance Air Burst
- Panoramic Night Vision Goggles
- CRASH Prompt Agent Defeat
- Surface Target Ordnance Package
- Laser Eye Protection



*AIR*

*SPACE*

*CYBERSPACE*



# AFRL Human Effectiveness Technology Transitions



*AIR*

*SPACE*

*CYBERSPACE*





# AF Office of Scientific Research



- Physics & Electronics
- Aerospace & Materials Sciences
- Mathematics & Space Sciences
- Chemistry & Life Sciences





# Air Vehicles Directorate



- Sustaining Today's Fleet
- Unmanned Air Vehicles
- Space Access & Future Strike Technologies

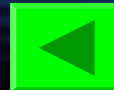




# Directed Energy Directorate



- Lasers
- High Power Microwaves
- Advanced Optics & Imaging







# Human Effectiveness Directorate



- Warfighter Training
- Crew System Interface
- Bioeffects & Protection
- Deployment & Sustainment







# Information Directorate



- Dynamic Planning & Execution
- Global Awareness
- Global Information Enterprise





# Materials & Manufacturing Directorate



- Metals, Ceramics
- Polymers, Composites, & Coatings
- Laser-Hardened & Sensor Materials
- Manufacturing Technology
- Non-Destructive Evaluation
- System Support







# Munitions Directorate (MN)



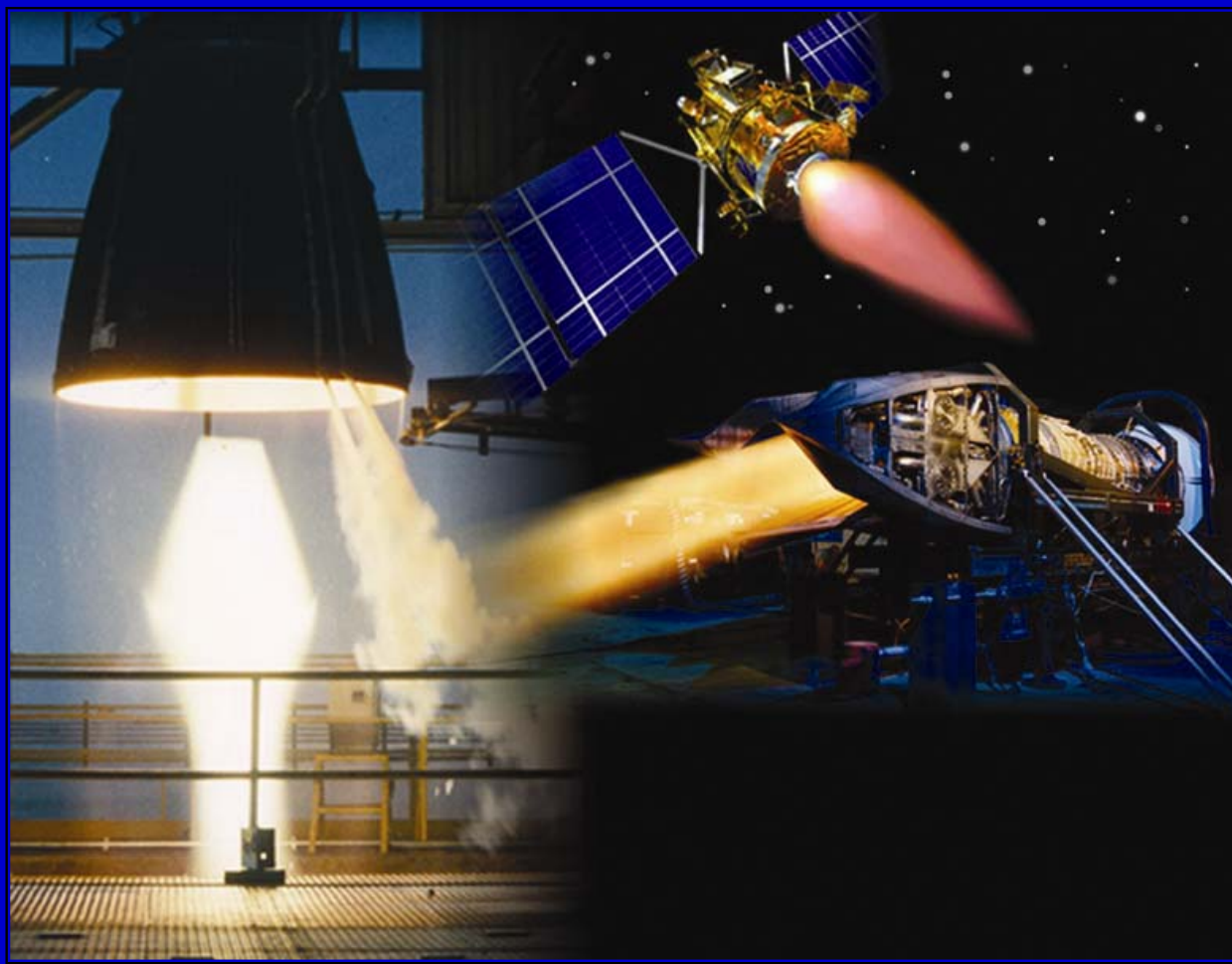
- Precision Munitions
- Counterproliferation

- Alternative Effects Weaponry





# Propulsion Directorate (PR)



- Turbine Engines
- Fuels & Lubricants

- Liquid & Solid Rocket Power







# Sensors Directorate (SN)

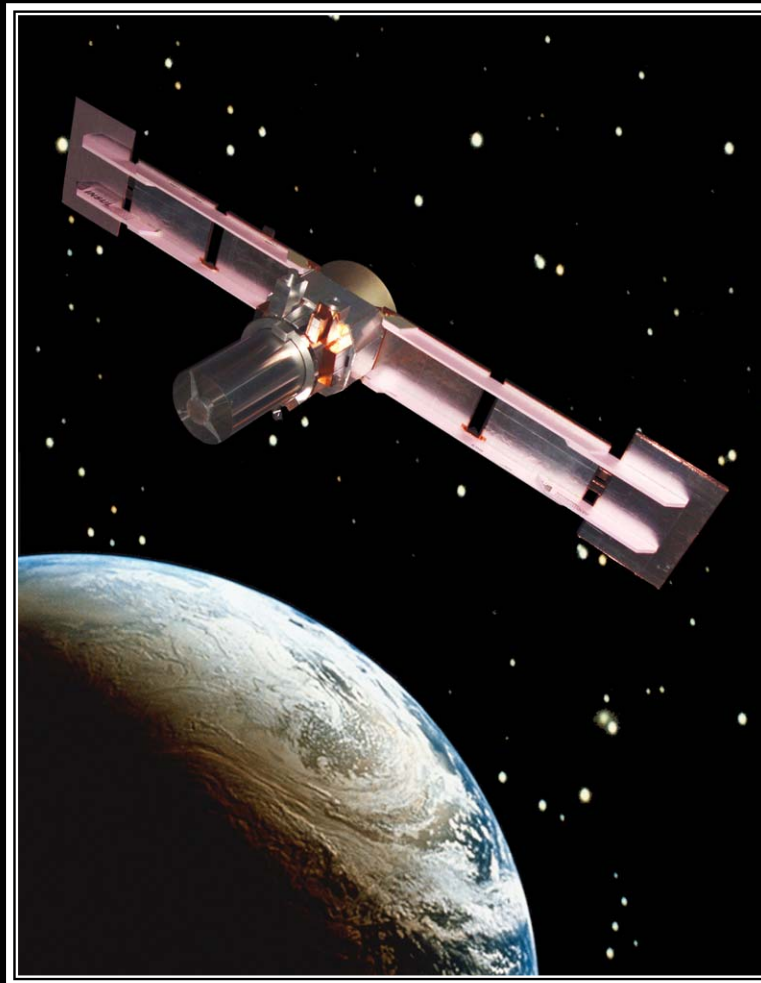


- Radio Frequency Sensors & Countermeasures
- Electro-Optical Sensors & Countermeasures
- Automatic Target Recognition & Sensor Fusion





# Space Vehicles Directorate



- Space-Based Surveillance
- Space Capability Protection

- Counterspace
- Space Access



# The ATLAS Powered Rope Ascender

## Enabling Rapid Vertical Mobility



## Student Technology Transition



- Fall 2004: Team ATLAS Enters *MIT-ISN Soldier Design Competition*
- Spring 2005: Working Prototype wins 3<sup>rd</sup> Place  
*Atlas Devices, LLC* Incorporates, files patent
- Summer 2005: Demo at Infantry Center at Ft. Benning
- Since then: 3 more patents, Partnerships, further iterations, and contract with US Army Rapid Equipping Force



# The Device



Original Challenge: 50 ft in 5 seconds with 250 lbs

- Device Weight: <25 lbs!
- 5 kW Mechanical Output in 25 lb package

Team ATLAS Original Design:

- Similar to Cordless Power Tool
- High Output DC Powertrain
- Innovative Capstan Mechanism
- Achieved 50 ft in 7 seconds with 250 lbs

Current Model: SRA03-1

- 17 lbs total weight
- 350 lbs at 5 ft/sec
- 600 ft vertical per charge



$$T_1 = T_2 e^{(\mu\theta)}$$





# Multiple Iterations, Multiple Uses

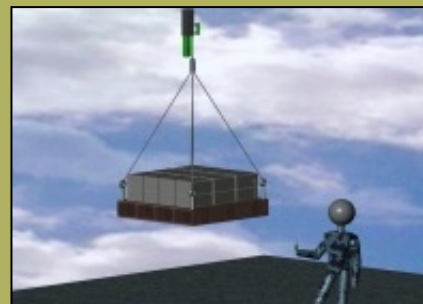
## Powered Ascent



## Rescue, Towing



## Equipment Hauling



## ...and More

...

- Ship Boarding
- Maritime Rescue
- Obstacle creation & removal
- Gate/door breaching
- Cave exploration
- Maintenance access
- Industrial load positioning
- Helicopter rescue
- Portable winching
- Minefield Raking
- IED Removal

...

- US Army Rapid Equipping Force Delivery
- Development of further iterations for Specialized Applications
- Upgrading capabilities: Lighter-Weight, Smaller, Faster
- Graduation
- *Further sales:* Small-batch orders of the SRA03-1 for testing, evaluation & refinement




Tim Fofonoff

- Ph.D. Candidate, S.M. Mech. Eng. MIT
- Member of MIT ISN and BioInstrumentation Lab
- Winner of 2006 \$50K MIT Hatsopoulos prize



Bryan Schmid

- S.M., S.B. Mech. Eng. MIT
- Serial Entrepreneur
- Padmakar P. Lele undergraduate teaching award



Nathan Ball

- S.M. Student, S.B. Mech. Eng. MIT
- All American pole-vaulter
- Winner of 2007 \$30K Lemelson-MIT Student Prize



Daniel Walker

- S.M. Student, S.B. Mech. Eng. MIT
- Experienced climber and rescue instructor
- Former MIT outing club president



## Emerging Technologies from the Army-Funded Institute for Soldier Nanotechnologies (ISN)

*by MAJ Rex Blair*

*Harvard Applied Physics Graduate Student and  
Uniformed Army Scientist at ISN*



Harvard  
School of Engineering  
and Applied Sciences



INSTITUTE FOR SOLDIER NANOTECHNOLOGIES

Enhancing Soldier Survivability

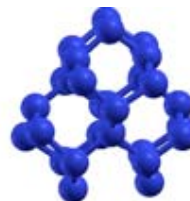
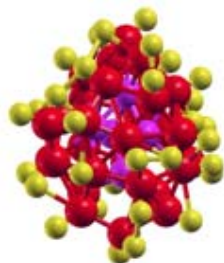
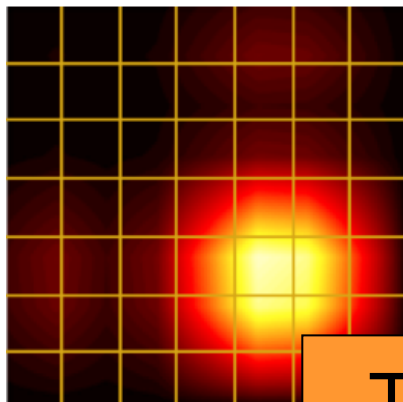


## *Boots to Benchtop... and Back...*

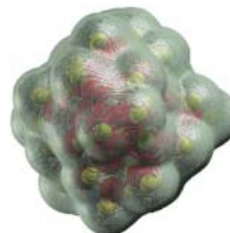
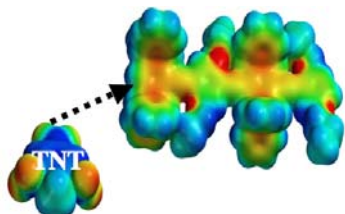
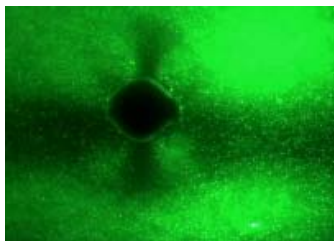




# Institute for Soldier Nanotechnologies MISSION



To dramatically improve the survivability of the Soldier by working at & extending the frontiers of **Nanotechnology** *through fundamental research*







# ISN Research to Enable Key Soldier Capabilities



## ***ISN Dedicated Facility***

*State of the art instrumentation*

*Multidisciplinary*

*40 Faculty (8 Departments)*

*80 Grad students*

*30 Post-docs*

*2 Uniformed Army Scientists*

*4 Civilian Army Scientists*

*8 Industry Visiting Scientists*



## ***Industry Consortium***



## ***Army S&T Labs***

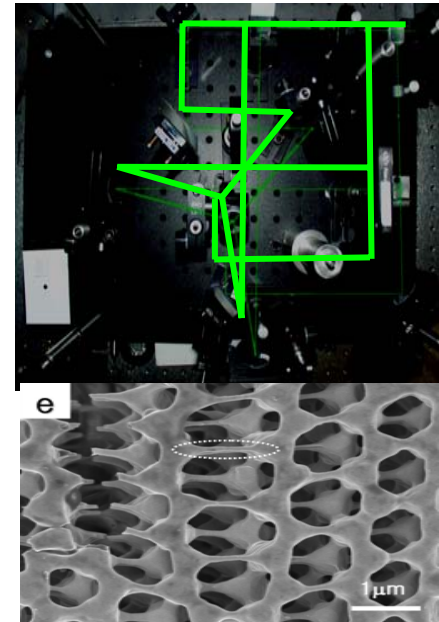
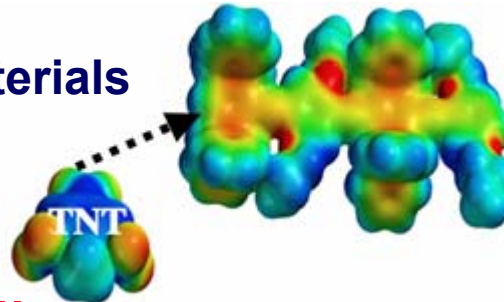




# ISN Research to Enable Key Soldier Capabilities



- **Protect:**
  - *Lightweight*, strong structural materials
  - **Ballistic + blast protection**
- **Detect *unseen threats*:**
  - **Explosives, chemicals, biotoxins...**
- **Enhance:**
  - **Adaptive, multifunctional materials**
  - **Soldier performance monitoring** (medical status)
  - Injury triage and **treatment for survivability**
- **Improve Performance:**
  - **Mechanical actuators: “exo-muscle”**
  - **Situational awareness**
  - Give individual Soldiers *small-unit* capabilities: chem-bio, awareness, far forward medical care

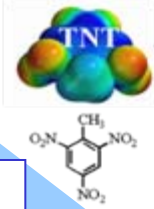


*Microtrusses via 3D photolithography*

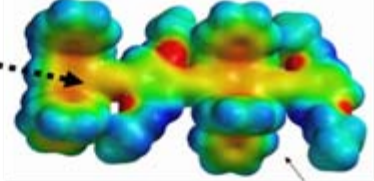
*Soldiers are FIRST customers  
for improved protection*

**MOLECULAR  
ENGINEERING:**  
designed molecules

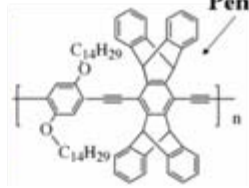
Blue=positive charge



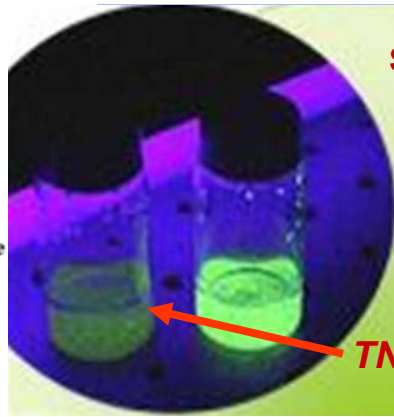
Red=negative charge



Pentiptycene

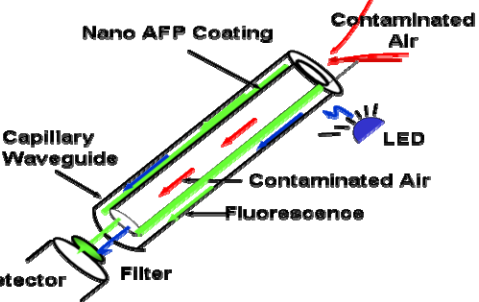


**SCIENCE:** Amplifying  
Fluorescing Polymer  
(AFP) developed by  
MIT ISN Prof Swager  
glows green, but  
quenches when  
TNT is present.



**TNT Detected**

**OPTICAL ENGINEERING:**  
integrated Detector/Sampler



**Assessments:**  
*USMC in Iraq (2004), ATEC in Iraq (2005)*  
**Procurements:**  
*SOCOM (2005),  
PMs (2006) for handheld + robot-integrated*

**REPACKAGING:**  
from DARPA Dog Nose concept  
to real Warfighter Device



**Fido<sup>TM</sup>**  
Explosives  
Detector



**DETECTION OPPORTUNITY:**  
Hidden explosives give off traces of  
chemicals, which may be detected.



**Army's  
Greatest  
Invention  
Award  
2005**



- **Near IR Quantum dots are functionalized for cancer, injected into patient; migrate to cancer cells (Bawendi)**
  - Surgeon assesses Near IR image before a single cut
  - Cluster == much cancer, few dots == less surgery
- **MEMS Microchip addresses Hemorrhagic shock (Cima)**
  - Enables rapid drug delivery
  - Military is “lead user,” leverages FDA approval process



Explore implant (long term) and “Epi-Pen” (short term) types of delivery

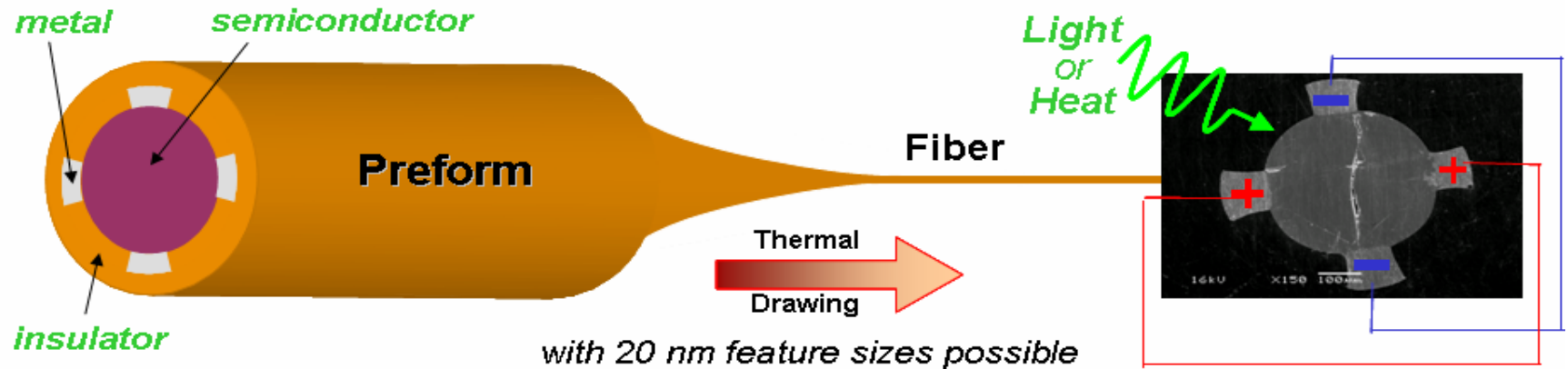
*Leveraging med research & partners:  
Saves lives + grows market + accelerates tech adoption  
== reduces costs + risks for Soldier applications*



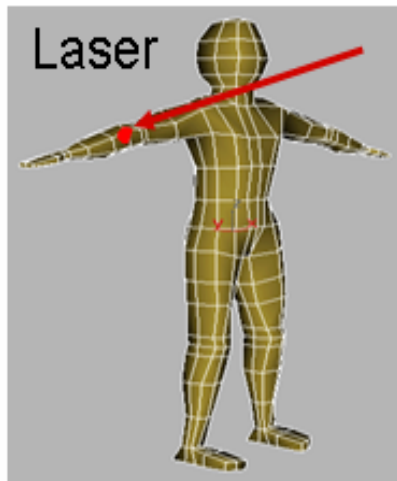


# Fiber Web Linear Sensors

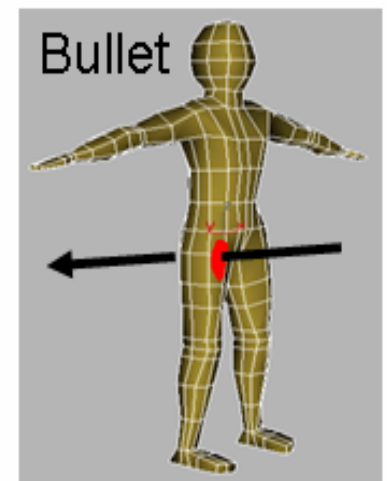
★ Optoelectronic **fiber-devices** for **light, heat, & acoustic** sensing:  
*Full-body sensing (Photonic Band-gap Fibers)– new paradigm fibers & fabrics that can see, feel, hear...*

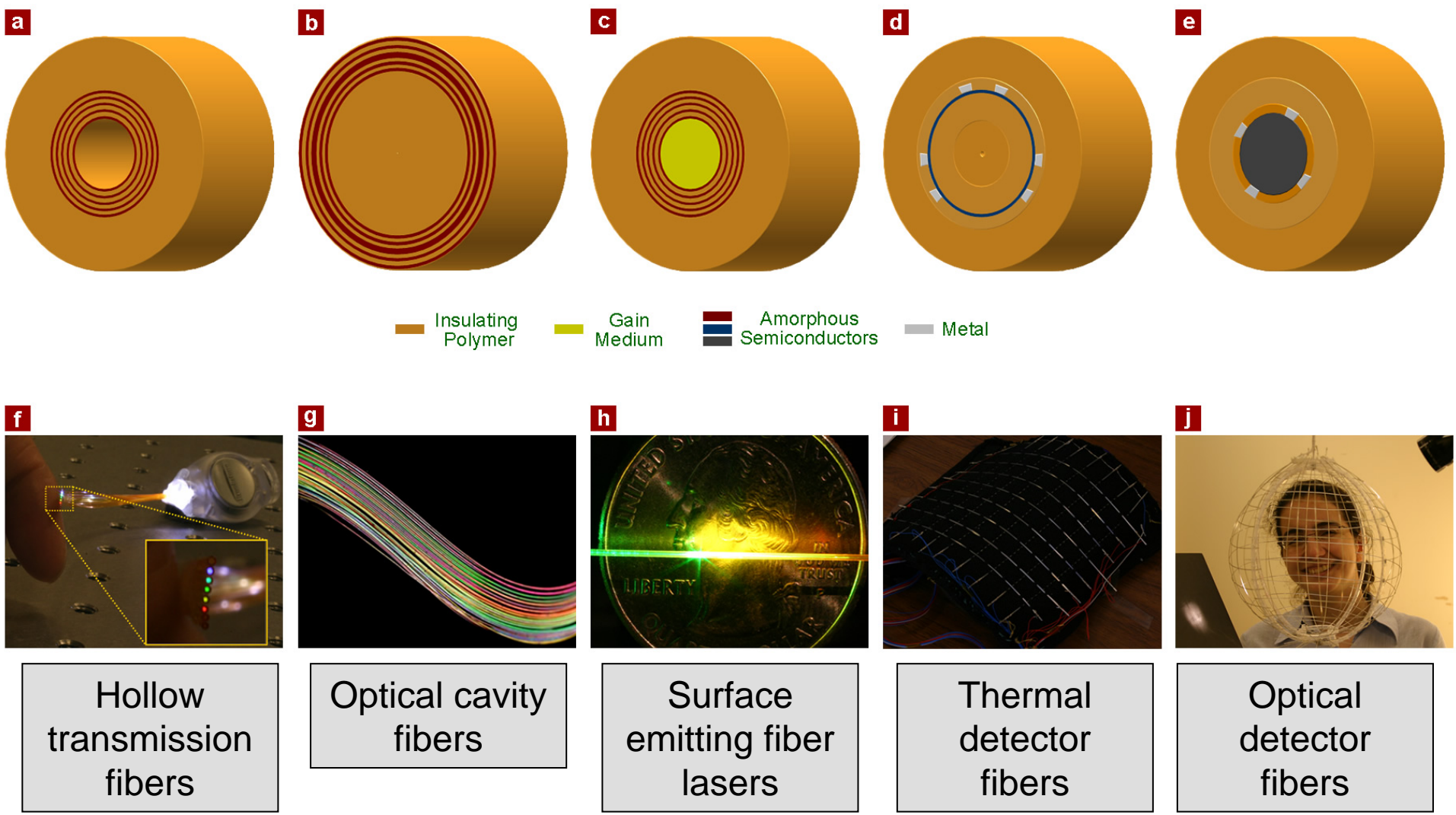


Full Body ID;  
Laser-to-Uniform  
Non-RF  
Communications;  
Improved MILES



Full Body  
Thermal Sensing  
*Remote Triage*







# ICOM-H Identification & Communication Helmet Prototype

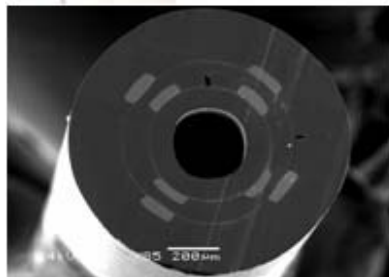
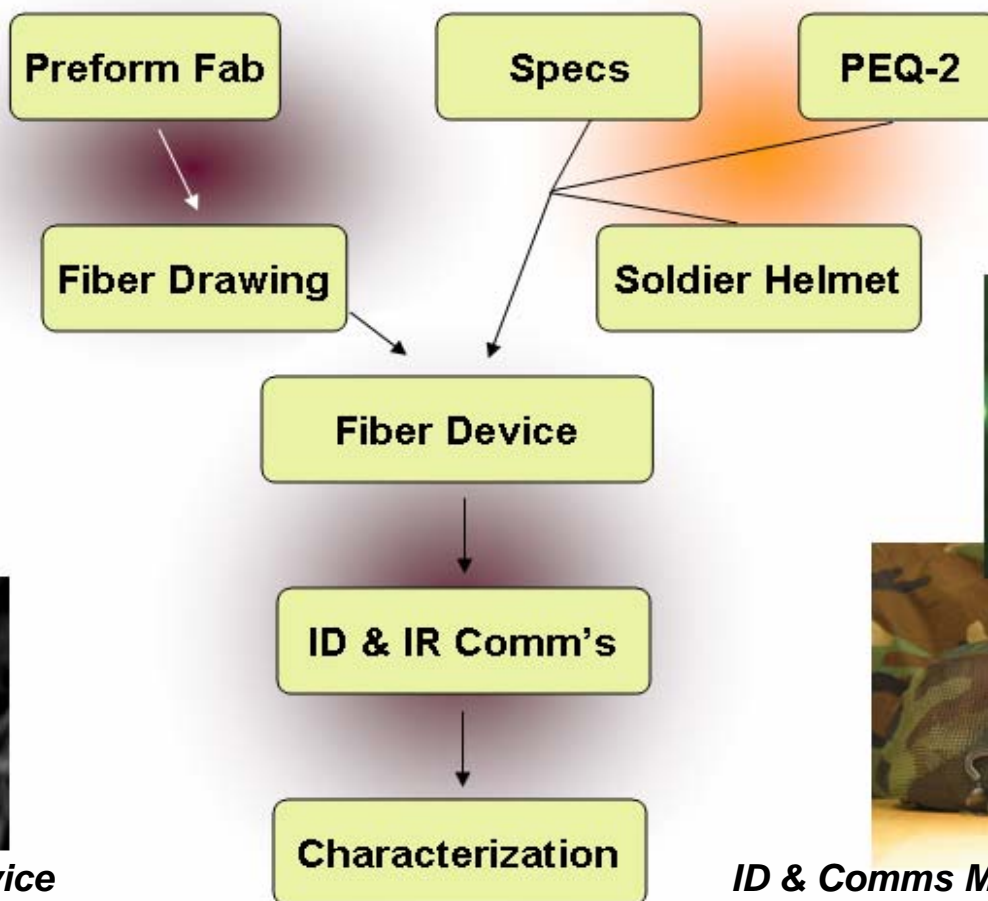


Design, fabricate, and implement an optoelectronic **fiber-device** covering for combat ID and line-of-sight IR communication



*Prof. Y. Fink*  
*Prof. J. Joannopoulos*  
*MAJ R. Blair*

*NSC –*  
*PM SOF Warrior*  
*R. Elder*



*Optoelectronic Fiber-Device*



*ID & Comms Multifunctional Helmet*



# ICOM-H Identification & Communication Helmet Prototype







# Be Alert for Opportunities: MIT ISN Soldier Design Competition



**MIT**

**SOLDIER DESIGN COMPETITION**

**Final Judging & \$10,000 in Awards**

**Tuesday, February 17, 2004**  
Wong Auditorium, ES1-115

5:30 pm: Poster Session  
6:30 pm: Final Presentations and Judging  
9:30 pm: Winners Announced

Teams will present prototypes of:

- Pocket-sized battle network
- An electricity generator that runs on a water bottle foot
- A rocket-launched aerial photography system
- A hand-held system for silent, over-the-shoulder visual communication
- and more!

**1) Flight Vehicle**

- \* 11 cm long
- \* 0.28g
- \* Disposable

**TacShot**

**2) Assembled Pictures**

- \* Zoom in for details
- \* Easy to copy/insert

**3) Ground Station**

- \* Laptop computer (or tablet)
- \* Automated software is simple to use

**ISN** **Directional Hand-Arm Communication System**

**Surreptiles**

Tony Eng, Byron Hsu, Forrest Liao, David Lin, Han Xu

**SOLDIER PROBLEM / CHALLENGE**

**Problem**

- ♦ Soldiers cannot always talk to one another, hear one another, or see one another

**Challenge**

- ♦ Develop system that enables soldiers in a squad or fire team to communicate both directional and non-directional messages without visual contact with team members
- ♦ System must allow quick, one-handed operation

**PROJECTED FINAL CAPABILITIES**

- Robust under all combat and peacekeeping environments
- Secure, short range wireless inter-soldier data transmission
- Addition of new commands on-the-fly



COL Terry Clemons, QM DCD & COL Ernest Forrest, TSM-Soldier, look on as Team TXI demo their novel parachute canopy release mechanism



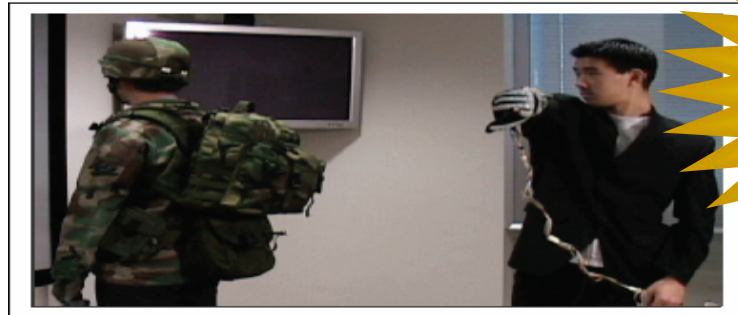
Judging the SDC



CSM Michael Kelso & COL Forrest examine TacShot's rocket-based photography system



Team Surreptiles, with COL Ted Johnson (center), show off their check for placing 2<sup>nd</sup> in the SDC finals



**SDC-1: Digitized Hand-Arm Signals  
with Personal Direction Reference:  
Incorporated as RallyPoint, Inc.,  
won 2 Army SBIRs (\$750K) for  
Future Force Warrior (FFW)  
Handwear Computer Input Device**

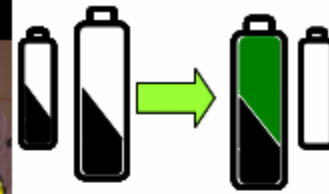
Army &  
Marine  
Challenges  
Ensure  
relevance



# ATLAS Powered Rope Ascender

LASmini.gif

## Three astronauts in flight suits are standing together, smiling and holding awards. The astronaut on the left holds a small plaque, the middle one holds a larger trophy, and the one on the right holds a yellow and black award.



**MIT Team Xitome:**  
**Kailas Narendran, CEO**

**PEO Soldier –  
2 designs (MIT +  
USMA) for Soldier  
field testing by Fall  
2005 (\$250K);  
FY07 contract for  
Iraq**



- 
- 1) \*Rocket launches to 100 meters  
\*Transmits video data down to ground robot  
\*Flight time: 10 sec.
- 2) \*Probe enters Mars atmosphere  
\*Parachute opens  
\*Probe descends to surface
- 3) \*Control station processes imagery  
\*Displays mosaic of 1 km area around ground vehicle  
\*Allows operator to zoom in on objects of interest
- 4) \*Probe lands on Mars  
\*Probe transmits data to control station  
\*Control station displays data to operator
- 5) \*Probe begins operation  
\*Probe transmits data to control station  
\*Control station displays data to operator



# TacShot

Goal: Involve undergrads in ISN

- Solve real problems, to help Warfighters
- Involve military: USMA, mentors, judges
- *Innovate to make a difference sooner:*  
*technology for Warfighters*





# Broader Impact & Media Coverage



**POPULAR**  
**science** **best of what's new**

2004

SonoPrep Skin Permeation Device  
Injecting drugs with acoustics—not needles



SBIR: SonoPrep  
Needle-less drug  
delivery for vaccines  
-- future battlesuit

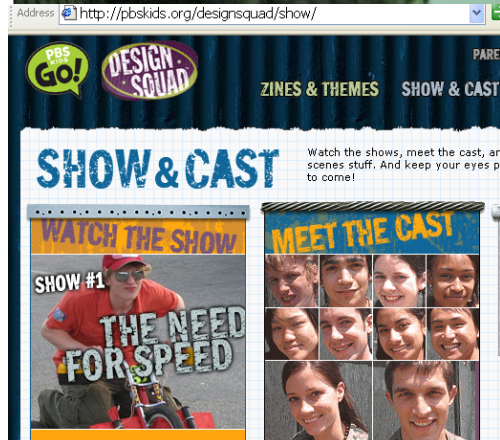
ATLAS / Nate Ball:  
MIT-Lemelson \$30K  
Inventiveness Award;  
PBS Design Squad;  
Army Rapid Equip Force  
\$120K Procurement of  
ISN SDC-award winning  
ATLAS Powered  
Rope Ascenders  
-- current needs

<http://wbztv.com/video/?id=29313@wbz.dayport.com>



[www.atlasdevices.com](http://www.atlasdevices.com)

ENABLING RAPID VERTICAL MOBILITY









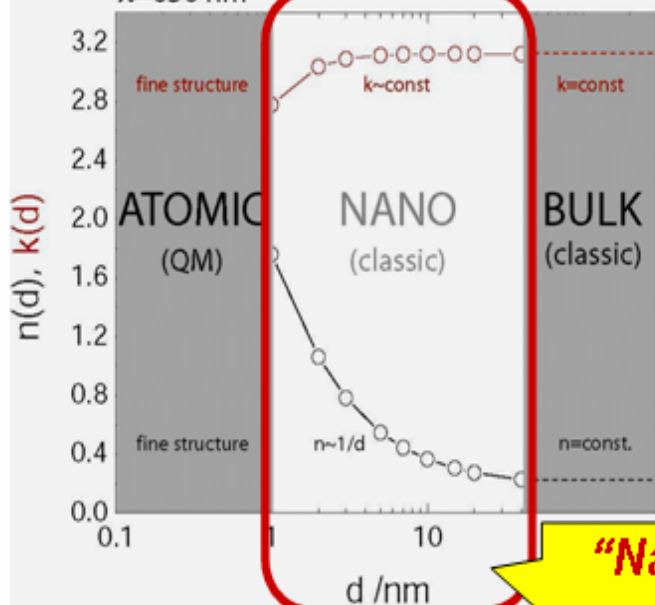
# ISN: Building Understanding of a New Class of Materials with a Human Customer in Mind



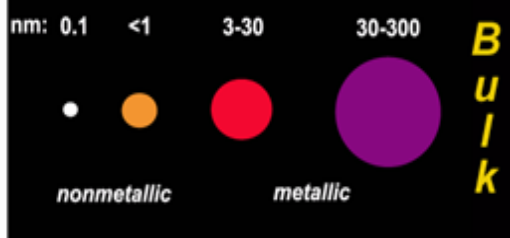
## Size Effects on the Optical Properties of Gold:

Plotting the Index of Refraction of Gold shows  $n + ik \rightarrow$  both  $n$  and  $k$  become size dependent

$\lambda = 630 \text{ nm}$



The color of Gold varies by Size



**"Nano" == Where things change**

Opportunities:

Understand the physics better

– new design space, new tradeoffs....

**Characterize properties and Explore MANY uses of these new materials**



**Define Parameter Space of new nanotechnologies – Don't target a single specific application**



# Soldier Capabilities Enhancement: Technology from the ISN This Decade



## Improved Performance:

- 'Exomuscle' actuators
- Situational Awareness (SA) from Quantum Dot thermal detectors & conformal computing displays

## Improved Protection:

- Sense unseen threats: chem/bio
- Nano-enhanced protective Materials (Transparent Armor, flexible protective materials)
- Smart coatings
- Smart materials with dynamic, switchable surfaces

## Improved Soldier Capability:

- Soldier bio-med: far forward triage & treatment (Needle-less drug delivery, dynamic splints...)
- Give individual Soldiers *small-unit* capabilities: Ubiquitous sensors, SA...



## Improved Development Tools:

- Advanced Modeling & Simulation
- New Materials Characterization, Design and Test Tools
- Nano manufacturing

## Broader Enhancements

- Nanoscientists work for Soldiers
- Nano-systems engineering know-how
- Commercial Apps for Soldiers, First Responders (via Industry Partners, Small Businesses, Soldier Design Competition)
- Unexpected advances

## Improved Military Capabilities:

- Improved Armor Materials
  - Lightweight materials for Army systems (Vehicles, weapons, etc.)
  - Advanced Materials + Optical Properties
  - Laser Detection Sensors
- \*\* Army Collaboration*



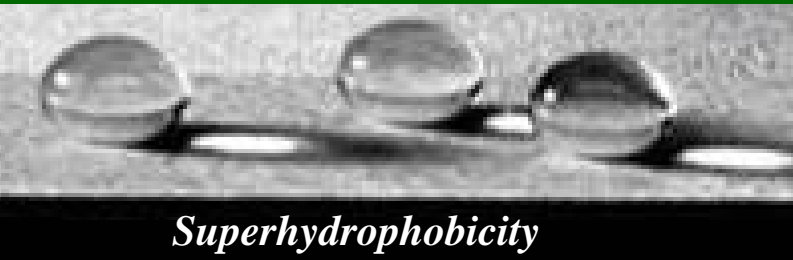
## **New Materials:** Biomedical Electrospun Scaffolds



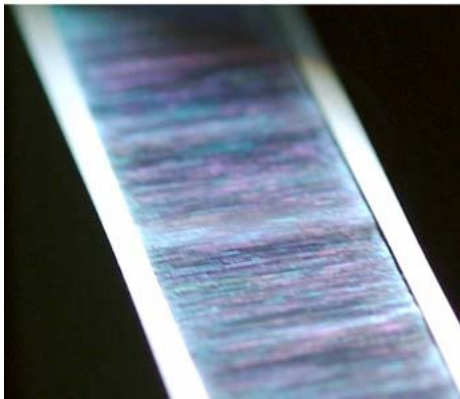
- **Project 4.4 partners Prof. Gregory Rutledge's team with Dr. Sonya Shortkroff (BWH and CIMIT)**
  - **Exploring electrospun PCL scaffolds to grow new biological tissues such as chondrocytes**

### Electrospinning & Polymer Nanofibers

(L. Chen, J.L. Lowery, M. Ma, M. Wang, KK.Gleason, RM.Hill /DCC, D.Kaplan, S. Shortkroff)

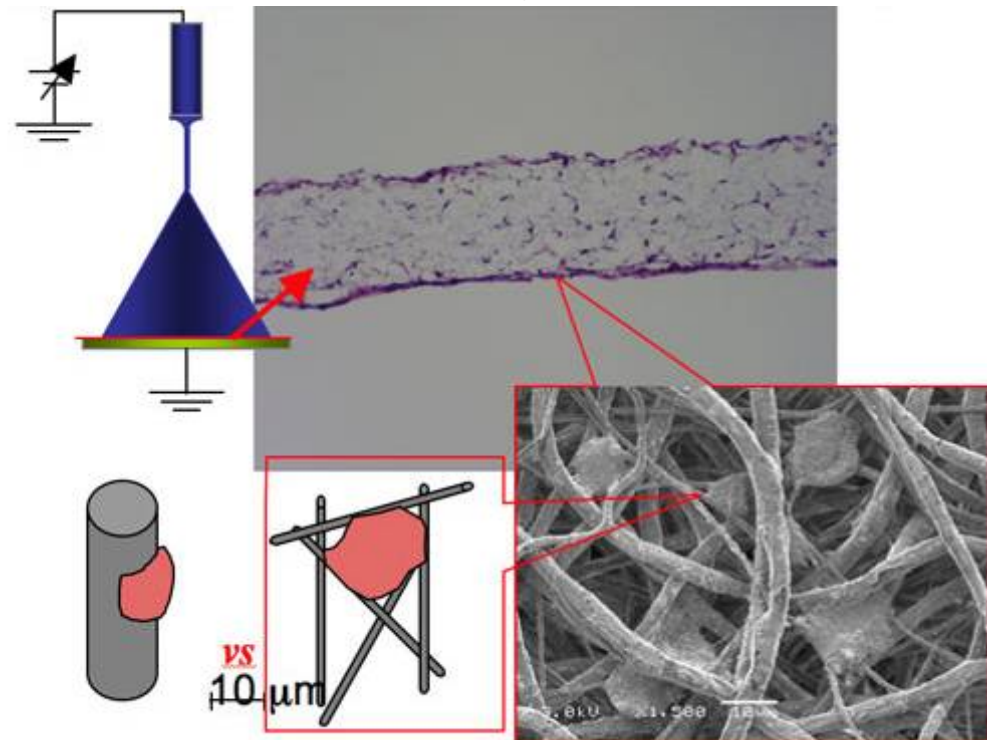


*Superhydrophobicity*



With R. Hill, DCC Visiting Scientist @ ISN, Rutledge group co-invented monodispersed color-shifting nanofibers

*Electrospun scaffolds exhibit unconventional cell/fiber interactions*







# Collaboration between ISN researchers and Army Scientists: On-Site Army Research Lab (ARL-WMRD) Scientist



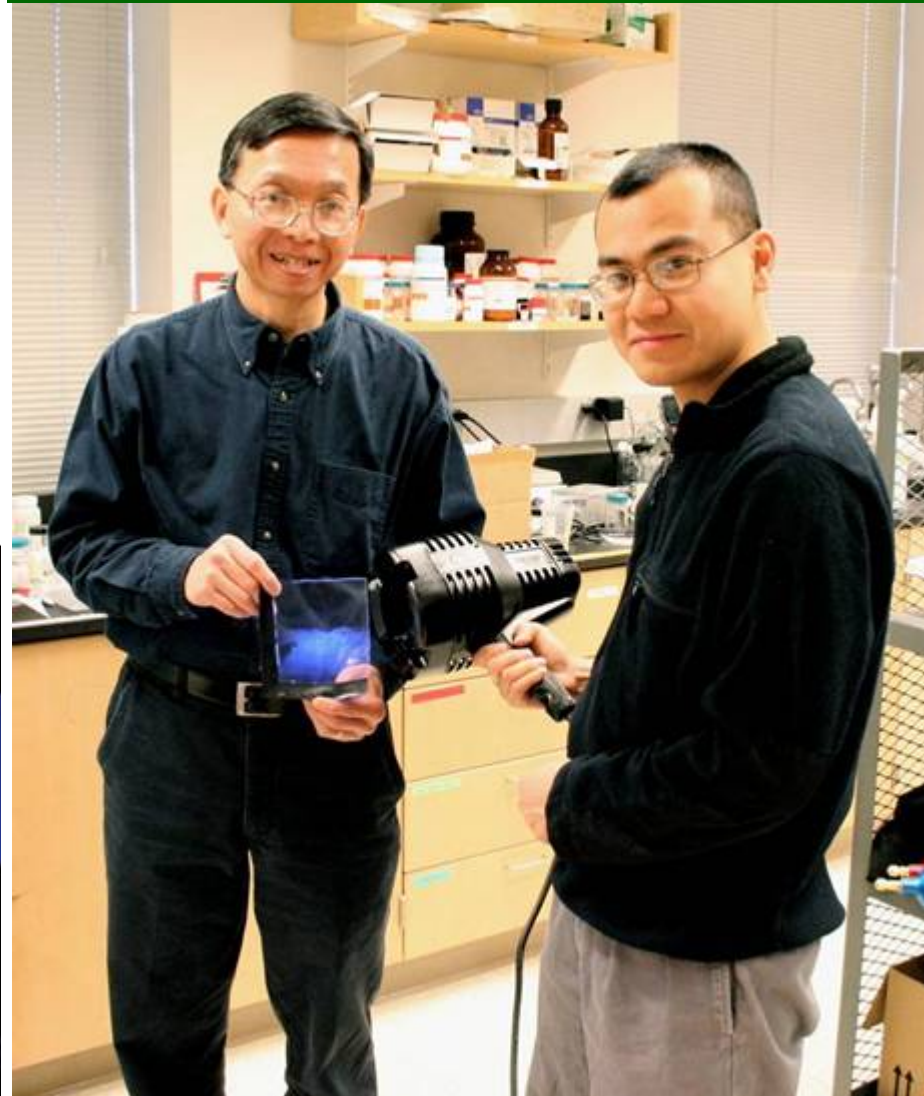
- Interesting material system developed at ISN
  - **Army Scientist Alex Hsieh** creates transparent armor, understands Army context
  - **ISN researcher Jian Yu** created a polymer system with embedded nanofibers
- Initial goal leads to transition opportunities:
  - Initially: reinforce eyewear
  - Discovered *interesting optical properties in UV*
  - Many potential applications (*optical tagging*):  
*lead users* for feedback / testing....



Optically transparent  
in visible light

Pattern detectable  
under UV

Army Scientist Alex Hsieh + ISN researcher Jian Yu



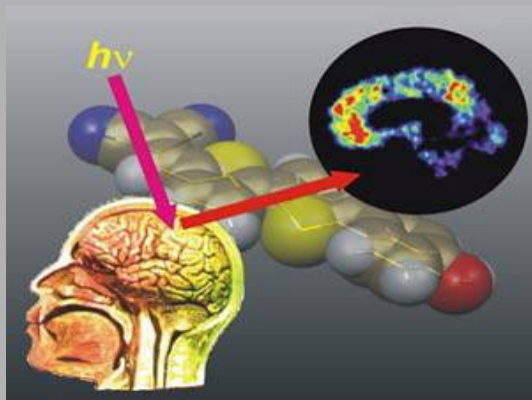




# ISN Tech Insertion: Army-funded 6.1 & 6.2 Science continues to improve explosives detection, leading to other capabilities



Extending chromophore use:  
from finding explosives (FIDO) to finding Alzheimer's:  
Swager's group designed new dye (NIAD-4) to bind with brain plaques (TBI?)

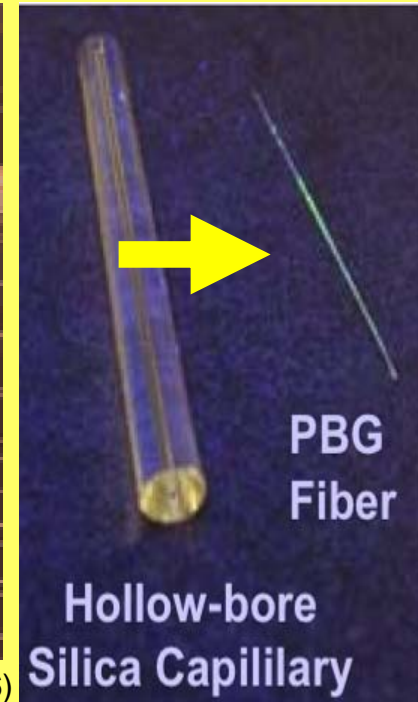


Changing chem platform:

Swager / Bulovic / Fink



*Nature Materials* 5, 532–536 (2006)



**Hollow Photonic Band Gap (PBG) Fiber:  
Smaller Size & Better Signal**

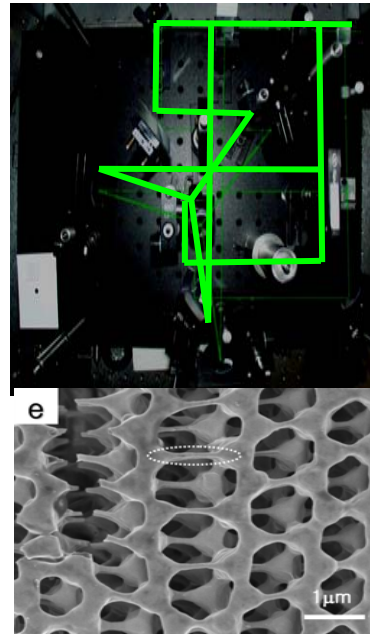
*Nomadics FIDO == PLATFORM technology to insert new capabilities*



# Future Developments... Information-bearing Protective Materials?



- Possible structural materials:
  - + Next-gen Light-transmitting polymer (fiber optics inside polymer matrix)
    - CNT-reinforced polymer matrix
    - Embedded FiberWeb fiber sensors
- Possible protective materials:
  - + 3D Microtruss system
  - + Holographic Data Storage
    - DCC subsidiary Aprilis
- Micropumps + FiberWeb == lightweight laser warning systems, systems (OPTICAL SOUND) etc...
- Lens-less Imaging with FiberWeb
- Flexible EMI Shielding with iCVD
- New computer interfaces: logistics ops

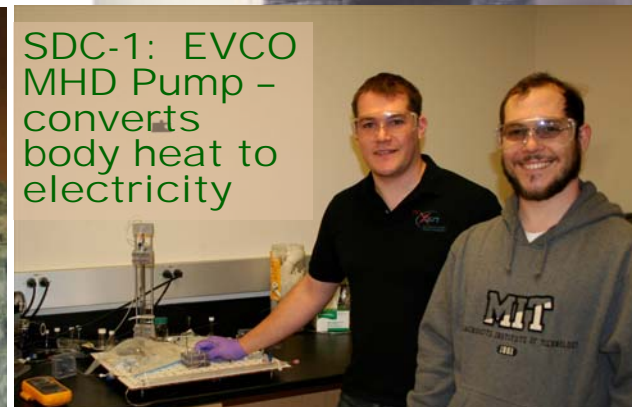


*Microtrusses via 2D & 3D photolithography*

LitraCon  
light-transmitting concrete  
invented by Hungarian  
architect Áron Losonczi –  
Structural material embeds  
optical fibers  
<[www.litracon.hu](http://www.litracon.hu)>



SDC-1: EVCO  
MHD Pump –  
converts  
body heat to  
electricity





# Army Expectations of Industrial Partners



## *Focus: Nanotechnologies to improve Soldier protection*

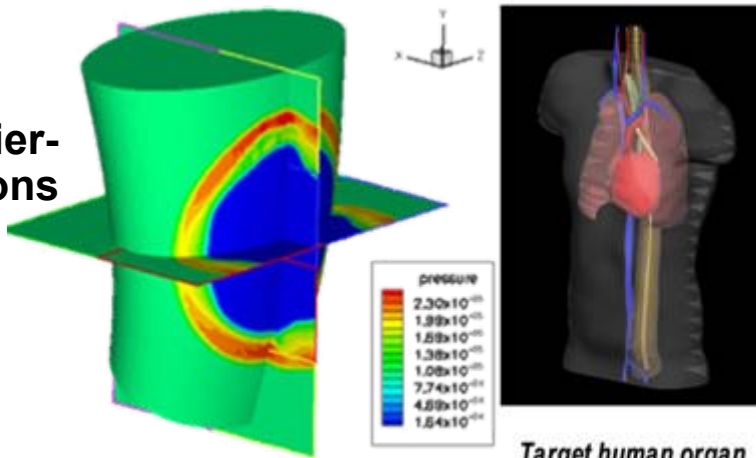
- Industry Partners should support Soldiers as valued customer
    - Collaboration with Army/DoD S&T encouraged
  - 6.2 Research should be scientifically compelling, AND should lead to commercial applications for nanotechnologies, leveraging 6.1 basic research
    - Two major paths:
      - Commercialize for open market; Army / other Gov't == Customers
      - With Army programs, customize for applications for the Soldier
    - Seek ways to expedite transition into products
      - Early products may be incremental improvements over current tech
- Soldiers = *Lead Users*, giving feedback on future directions





## Energy Absorption: Modeling Soldier-Blast Interactions

Radovitzky



Simulation of lung injury due to blast overpressure (BOP)

Target human organ models



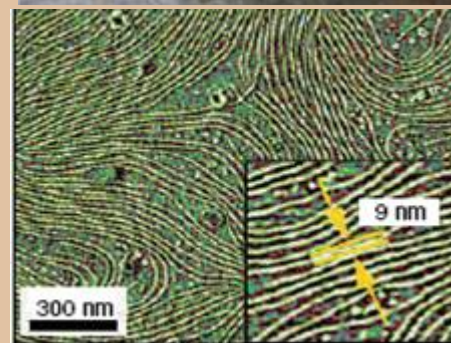
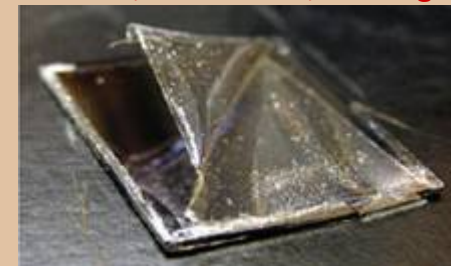
Army ARL-WMRD  
@ISN: Scientist  
Alex Hsieh



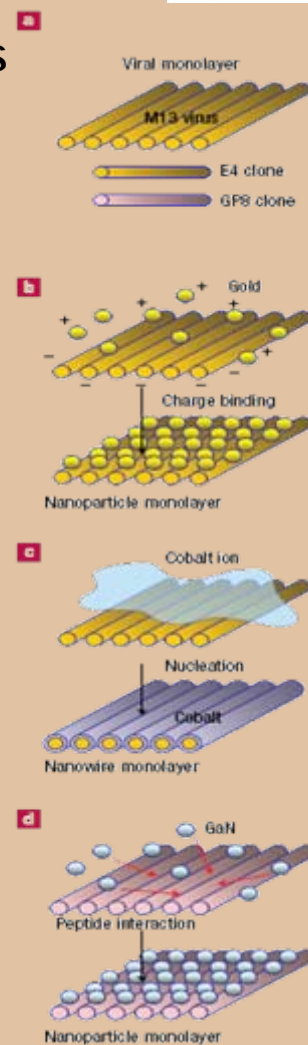
Transparent Protection:  
Shear Thickening Foam system,  
tested at ARL-WMRD

## Portable Energy: Virus-based Self-assembly of flexible Lithium batteries

Belcher, Hammond, Chiang



Nature Materials, Vol 5, Mar 2006







# SDC Transition: Ancile Warning System



Cadets 1st Class Brian Lebiednik and Greg Isham (front center and right) smile as Ancile system picks up another mortar round at the C-RAM exercise at Yuma Proving Grounds, AZ. Army officials said they hope to issue pagers to Soldiers in Iraq within the next nine months. *U.S. Army Photo*

**Reward Innovation for Soldiers!**

## ***“Cadet project could save lives”***

**By MAJ Fernando J. Maymi, D/EE&CS**

***“Pointer View,” May 27, 2005***

<http://www.usma.edu/PublicAffairs/PV/050527/project.htm>

***Four senior USMA cadets helping make troops safer.***

**EECS senior project for USMA Cadets 1st Class:**

**Jeffrey Hermanson, Jamie Dayton, Brian Lebiednik, Gregg Isham**

**Cadet team designed and built an Ancile pager  
to warn Soldiers of incoming artillery/mortar strikes**

**Army tested at Yuma PG: “significant advance notice each time”**

**Project sponsor Paul Manz, technical director for ground  
combat command and control in Fort Monmouth, NJ, developed  
a plan to field pagers within 9 months.**

**Their senior project was a great way for them to help Soldiers:**

***“wonderful that we were able to do something that  
helps keep our fellow Soldiers safe while  
they are working to keep us here at home safe”***

**➔ Florida-based Mahdahcom  
licensed + is producing Ancile**

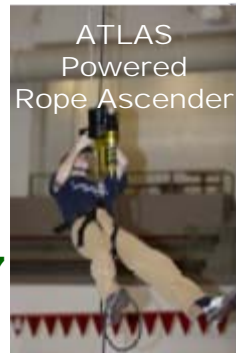


# Dealing with Success: Innovation Challenges

Secretary of the Army joined us for ARO @ ISN Workshop, 11 Apr 2006



- In innovation, tech **availability**  $\neq$  **adoption**
  - Absorptive capacity issues
    - Practice for major change (FCS)
  - Clockspeed differences
  - Impedance mismatch
- Outsourcing risk == outsourcing process
  - Other peoples' processes reward differently
    - MIT TLO  $\rightarrow$  patenting IP, \$\$\$
    - Small business marketing needs vs. **OPSEC**
- Entrepreneurs need to survive
  - First customer == favorite customer
    - Lead users: **joint**, varied missions
    - Champions crucial
  - Timelines are very different!!
    - RallyPoint: Apr 2004 vs. FFW Dec 2007
- Need to help manage risk
  - Army can help! Eg, Safety Certs, operational assessments
  - Need business growth: shared costs / revenues
- Innovation can help the Army & the Army can help innovators!
  - Need adaptive leaders who train in innovation
    - **Science must translate to technology**
    - **Technology must come to market**
    - **Customer purchases make a difference**



Good challenges to have....







# Support to Current Operations

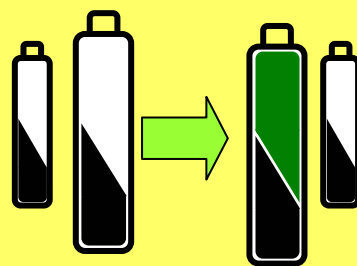


- Nomadics FIDO explosives detector has been in Iraq since Summer 2004: limited assessments by Soldiers and Marines, and screening with EOD Tech
  - ➔ Detects TNT/TNT-based explosives, usable in several modes: handheld, on robot, underwater, down wells
  - ➔ Air Force bought systems for cargo screening
  - ➔ Army Rapid Equipping Force and Joint IED Task Force funding Iraq-based ATEC *Warfighter Assessment* of integrated FIDO on iRobot PackBot for vehicle inspection
- PEO Soldier procured ISN Soldier Design Competition award-winning Battery Power Scavenger designs from undergraduate teams for Soldier assessment
  - ➔ Designs from Supercharged (USMA) and Xitome (MIT) help Soldiers by scavenging power from used AA batteries for rechargeable batteries

**Fido**<sup>TM</sup>  
Explosives Detector



USMA Team Supercharged: Cadets  
Nick Barry, Jeremy Spruce, Walter Velasquez



MIT: Xitome CEO Kailas  
Narendran shows PowerPlus



Election Day 2005:  
AI Kasic, Iraq -  
Nomadics SME: Brian  
Heishman screened with FIDO



# ISN "Fiber Web" linear sensors (Profs. Fink & Joannopoulos)



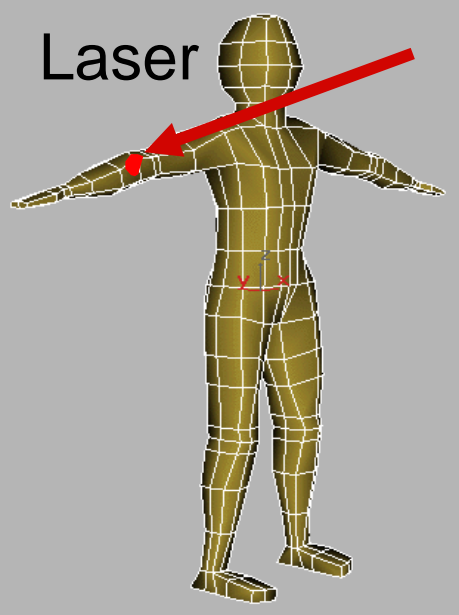
*Same Material: FIBER WEB:  
Senses light from lasing  
(both ops + embedded training),  
Temperature for well-being,*

*Lasers for intra-squad comms  
(when RF not available or desired)*

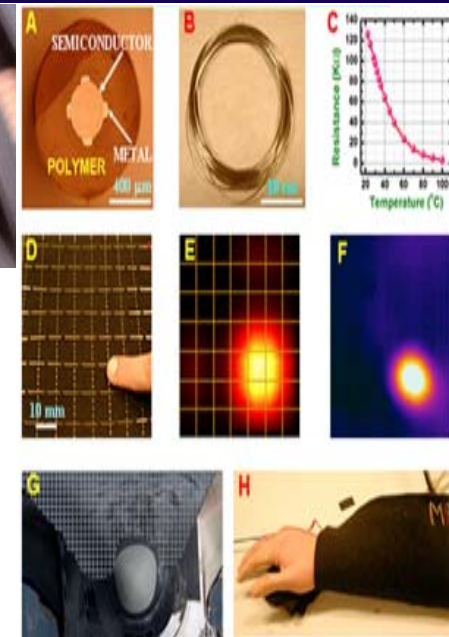
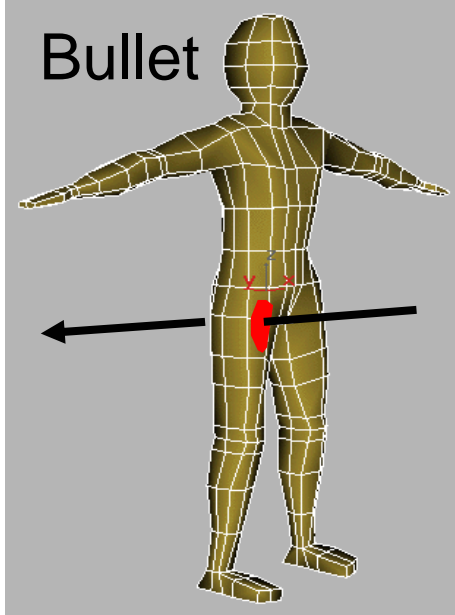
**Full Body MILES++  
For Realistic Training**

**Full Body Thermal  
Sensing**

**Laser**



**Bullet**



-- Rapid helmet prototype for  
PM SOF Warrior CID user demo  
27Nov2006

-- Based on 20Dec2006 VTC,  
PM Live Training Systems will assess  
for potential use in  
Training devices e.g. MILES, E-Targets  
Challenge: Tech vs. OPSEC





- **Why ISN good idea: ISN acts as hub**
  - **Multi-dept professors brought together**
    - **Chem Eng (Gleason) + Chem (Klibanov)**
    - **Big discoveries at the crossing of academic boundaries**
    - **Army benefits from interaction of smart people**
      - **They benefit by meeting / knowing customer**
- **My role: Military liaison – people get immediate feedback from me as combat commander on technology uses**
- **Some ISN projects**
  - **FIDO**
  - **Cima Microchips vs. hemorrhagic shock --??**
- **My special project**
  - **FiberWeb ICOM-H: comms over light**
- **SDC rapid innovation program: How are we helping the Soldier today**

# Breakthroughs, the Product of Innovators

By Burt Rutan



# Breakthroughs: Why

- Technical accomplishment
  - Defines our species - separates us from other animals
  - Satisfies desire for continuous improvement
  - Provides for 'well being'
- Without breakthroughs
  - Boredom and mediocrity
  - Low expectation of future
  - Degradation of national security

# Breakthroughs: When

- When do breakthroughs occur?
  - During or shortly after:
    - Crisis, chaos, “bad” times
  - Not:
    - During tranquil, stable, “good” times
    - When highest priority is equal status of populous
- We are creative when scared



# Breakthroughs: How

- Breakthroughs cannot be specified by massive funding
  - Example: Low cost space access was the **goal** of the Space Shuttle Program
- Breakthroughs occur due to the working environment
  - Kelly Johnson 'Skunk Works'

# Breakthrough Observations

R & D experience has **inverse** relationships

- Value of product....Self-perceived sophistication of customer
- Content of new technologies....Program timeline
- Product's worth....Risk averse role of managers

# The management of innovators

Manager's only tasks: Set goal and get funding

- Set goal high (50% should say impossible)
- Reward achievement of goal (power of a prize)
- Let the innovator decide what risks to take
- Leave them alone and keep others out
- Applaud courage and expect multiple failures
- Allow *fun*

# Focus for the management of innovators

*“If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.”*

*-Antoine de Saint-Exupery*



# Exposure During Childhood Leads to Adult Technical Innovation

- Inspiration begins early – Kids ages 3 to 14

# Our Responsibility Now - Create Progress to Inspire our Kids

- Our Technology leaders had their inspiration in exciting times
- Periods of extreme technical progress: I will discuss three.
  - Aviation's Renaissance, 1908 to 1912
  - My inspiration, 1946 to 1957, post WWII
  - Gagarin to Skylab, 1961 to 1973



# Aviation's Renaissance 1908 to 1912

- Early 1908, < 12 pilots
  - Then “I can do it”
- By 1912
  - Hundreds of aircraft types in 39 countries
  - Aircraft invented by ‘Natural Selection’
  - Airshows with 400,000 attendance



# Kids Were Inspired by Aviation's Renaissance





# Which Kids Were Inspired by Aviation's Renaissance?

- **Every one** of those that inspired me.
  - Wernher von Braun
  - Kelly Johnson
  - Charles Lindbergh
  - Jack Northrop
  - Ed Heinemann
  - Howard Hughes
  - Sergei Korolev
  - Alexander Lippisch
  - Bill Lear





# Aerospace Activity 1946 to 1957

## During my Childhood (age 3 to 14)



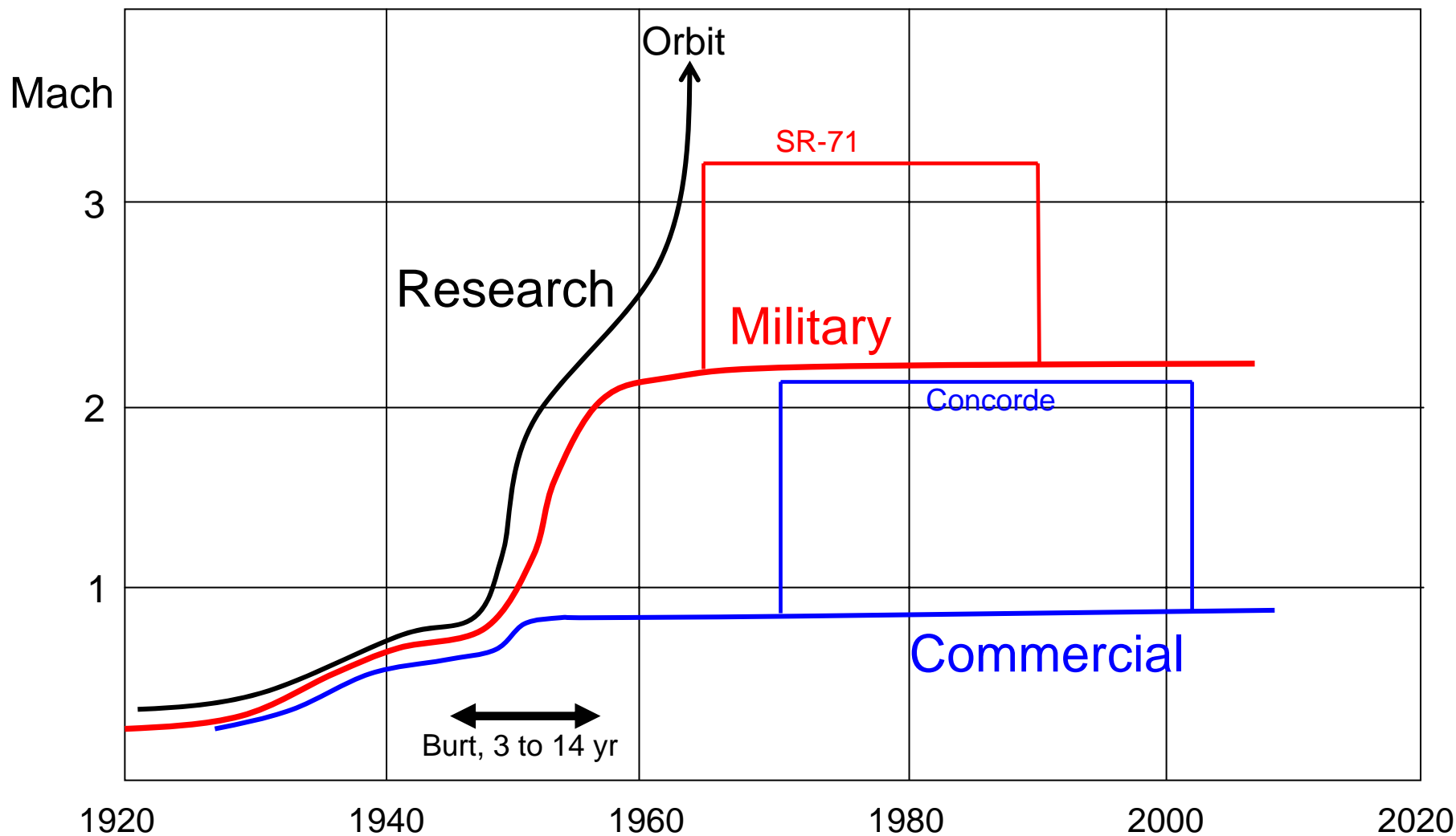
The Jet Age starts. The Missile Age starts.



# Childhood Activities Were Driven by Aviation Progress



# A Jump in Performance Inspired me during childhood





# My Post-College Career Choice: Aviation (unusual for space-crazed 1965)

- Airplanes, not the moon
  - Realist?
  - Burt the conservative?
- General Aviation was the passion, but Air Force Flight Test, was the Compromise.

# Air Force Flight Test 1965 to 1972

The “whole-package” experience  
Best training for an aircraft designer





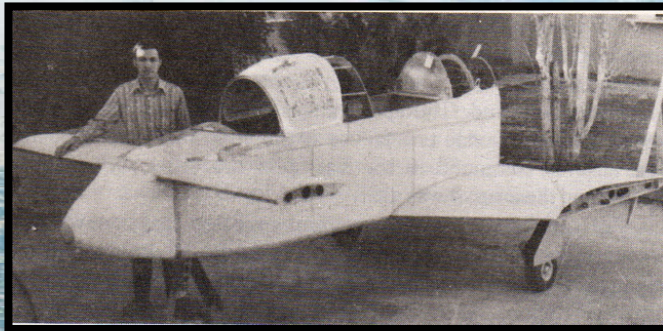
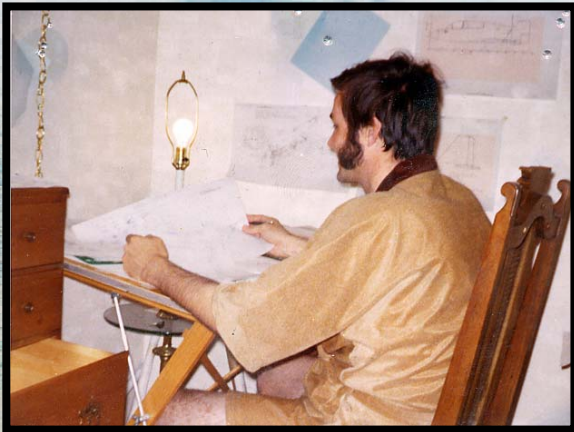
# Military Flight Test Not Fulfilling

- Great experience, but not creative
- Light aircraft – target rich for innovation
- Light aircraft were the ‘fun hobby’
- The dream of a job as fun as the hobby

# A Big Jump 'Down' 1972

## Rutan Aircraft Factory

### The entrepreneur can control his destiny





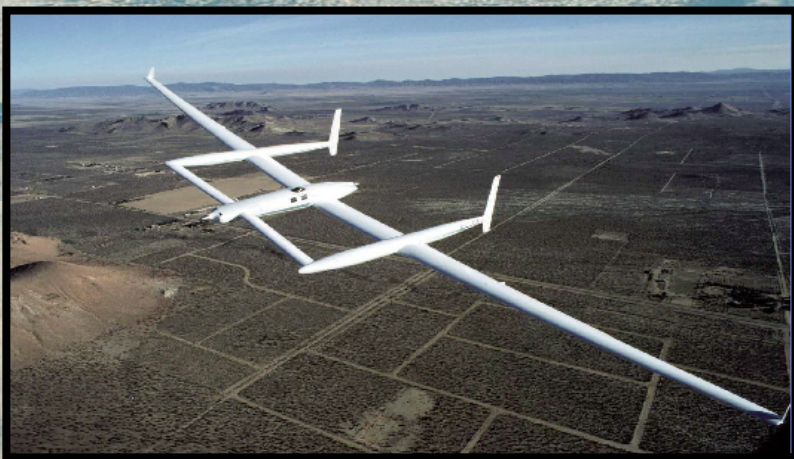
# The Projects of RAF 1972 to 1985





# The Public Interface

## The Thrill of the Milestone





# Scaled Composites Company 1982 - Present

- Composites Structural Technology
- Aggressive projects, big customers
- World-Class Staff – shop and engineering
  - More folk to have fun





# Scaled's Aircraft



**Predator**  
1984



**Pegasus**  
1990



**Raptor D-2**  
1994



**DC-X**  
1995



**Roton**  
1999



**SpaceShipOne**  
2003



**Scarab**  
1986



**ARES**  
1990



**Vantage**  
1993



**X-38**  
1997



**White Knight**  
2002



**Starship 1**  
1983



**Triumph**  
1988



**Raptor D-1**  
1993



**Proteus**  
1998



**X-47**  
2001



**Microlight**  
1983



**ATTT**  
1987



**Lima II**  
1991



**VisionAire  
Vantage**  
1996



**Adam Model 309**  
2000



**Global Flyer**  
2004



**CM-44**  
1987



**Pond Racer**  
1991



**Freewing**  
1994



**V-Jet II**  
1997



**TAA-1 POC**  
2002





# Why The Perfect Accident Record?



# The U.S. Manned Space Renaissance 1961 to 1973

- Progress accelerated by Sputnik/Gagarin 'losses' – The need to regain National prestige
- A wild ride to recover prestige
  - Mercury, Gemini, Apollo lunar, Skylab and planetary exploration
- Enormous courage applied to huge risks
  - Five launch systems in seven years
  - Apollo 8/Saturn 5 risk
  - Lunar-orbit-rendezvous decision



# American Manned Launch Systems

Redstone



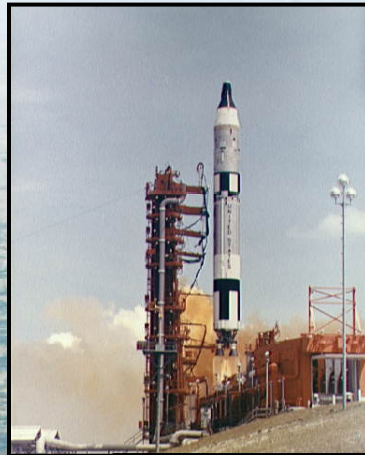
Flights: 2

Atlas



4

Titan



10

Saturn



15

Shuttle



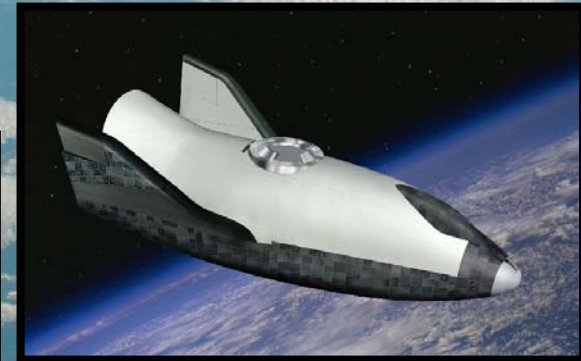
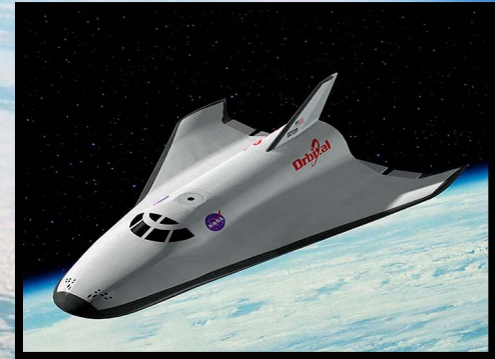
114

Each was abandoned when more expensive one became available - not matured for affordability



# The Collapse that Followed 1973 to Present

- Abandoned genuine search for safe, efficient orbital manned capability.
- Abandoned lunar capability
- Risk-averse attitude: study it, do not try to fly.
- Lacked the courage to fly new research programs



# The Most Impressive Aircraft? Lockheed SR-71

Designed in 1959, only 14 years after first operational jet.

First flown in 1963.

Abandoned in 1998, retreated to 1956 U-2.



P-80

1945





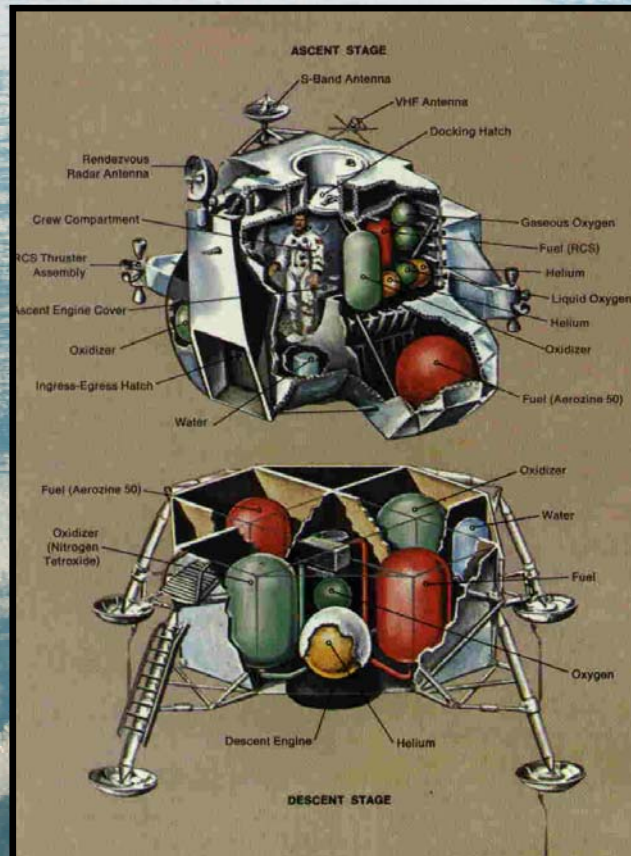
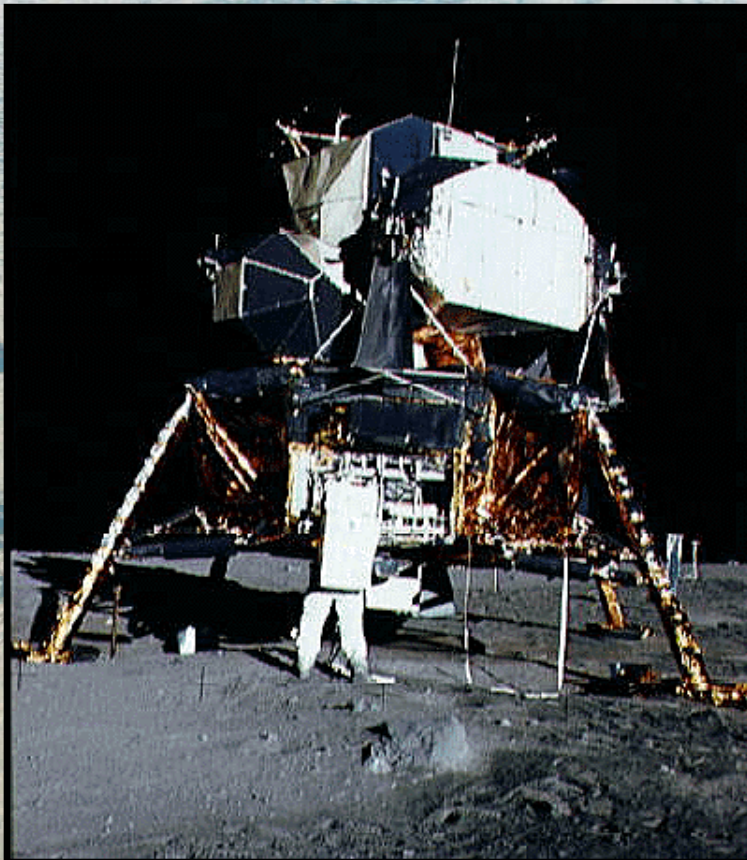
# The Most Impressive Spaceship?

## Grumman Lunar Module

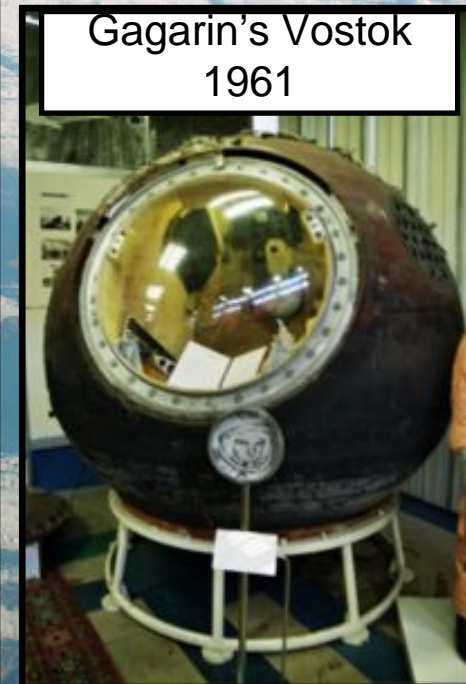
Designed in 1964, three years after Gagarin

First flight 1968

Abandoned capability in 1972



Gagarin's Vostok  
1961





# What is wrong with this picture?

1925



1965



2005



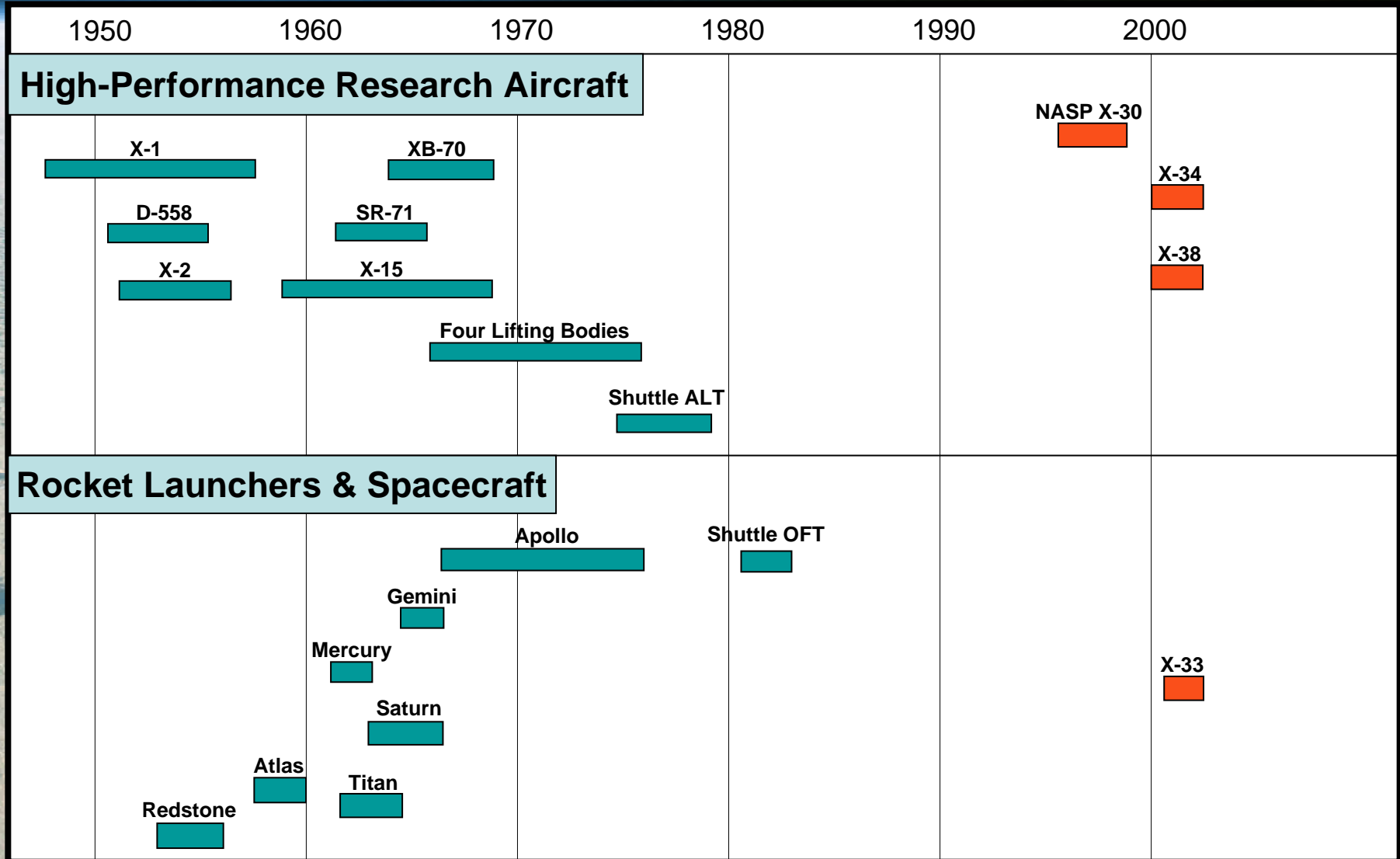
# F-22 Raptor & F-35 JSF

The only new USAF fighters for the next 40 years?

- Another 40 years with 1960's performance?
- Requirements based on perceived need, not a desire to find performance breakthroughs.
  - Air superiority in < 2 days, last two decades.
- Requirements direct Development Programs, not Research.
  - Industry employs a new generation of aerospace engineers who think development **is** research.
  - Risk averse requirements breeds risk averse technical progress.

# Historical Perspective

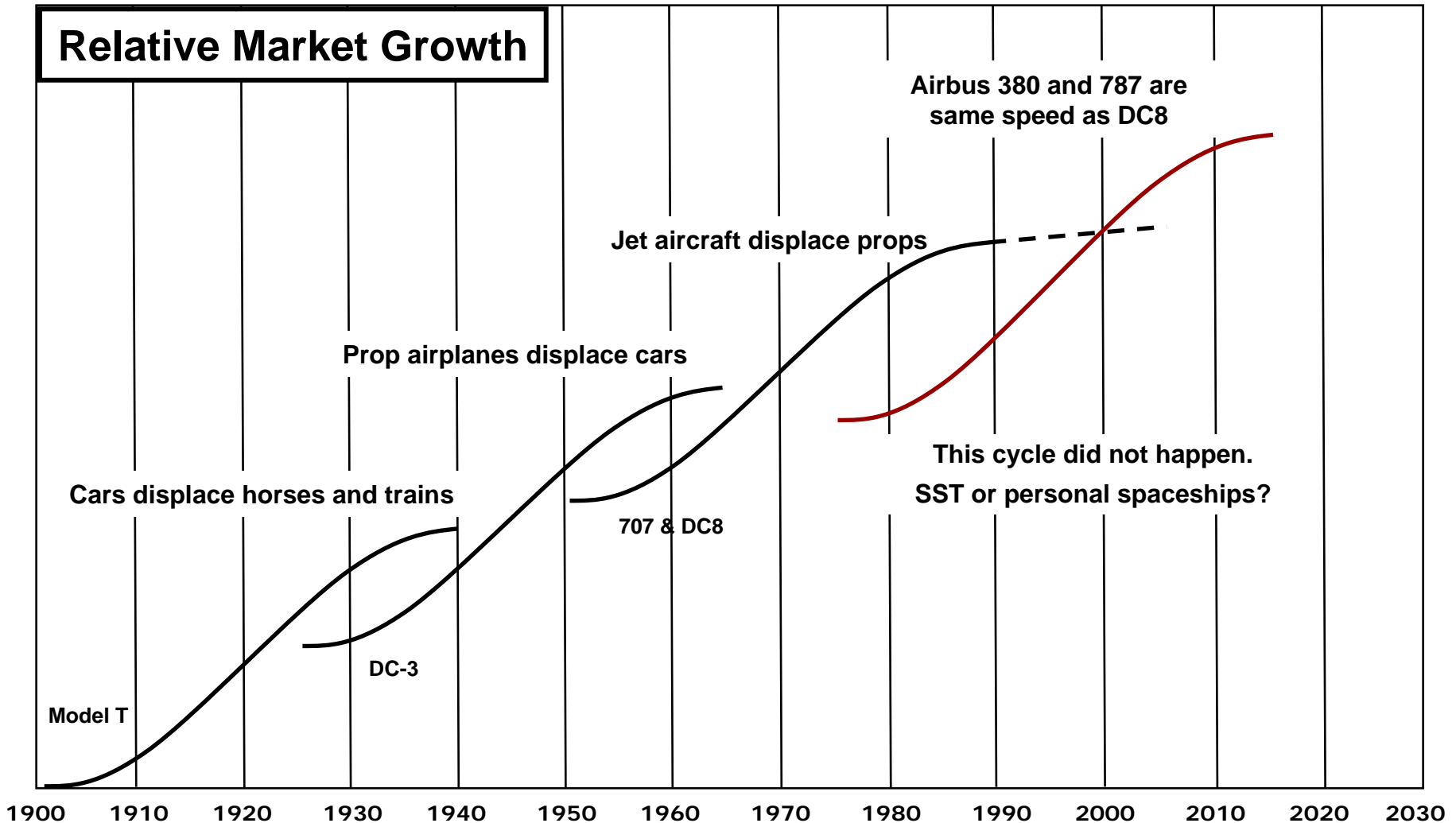
## Manned Research Programs That Expanded the Envelope





# Higher Speed Travel – Forty Year Cycles

## We are Overdue - Recent Cycle is Missing



# Orion/Ares, NASA's road ahead

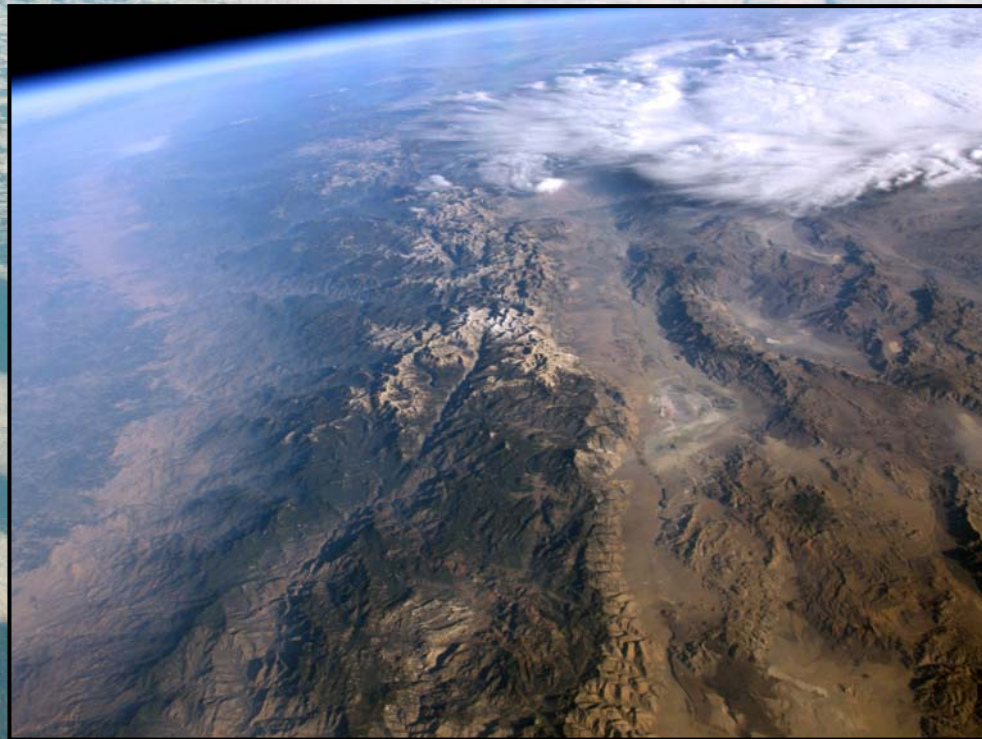
- Retreat to Apollo/Shuttle-era hardware for manned orbital and lunar operations
- No opportunity to discover breakthroughs
- Another 13 years without progress for Personal Spaceflight
- Lack of challenge for another full generation of spacecraft designers.



# Our Sub-Orbital Space Program

## The Goal is Fun, To Enjoy This View

To stimulate a Private Spaceflight industry,  
so others can enjoy this view





# Space, for us – Why Now?

- SpaceShipOne was a personal goal, not a customer request
- Inspiration from visionaries' courage
  - Required my exposure **as a child**, not a view of current aerospace practice
- The 'New Space' investors/developers – were, **as children** inspired by Sputnik to Apollo
  - Allen, Musk, Bezos, Branson, Bigelow, Page/Brin & Carmack

# Our Research Test Pilots





# Launch Aircraft - White Knight

- Identical systems components to Spaceship.
- Provides pilot training for boost, entry & landing.





# SpaceShipOne

Air-launched  
Feathered entry  
Runway landing

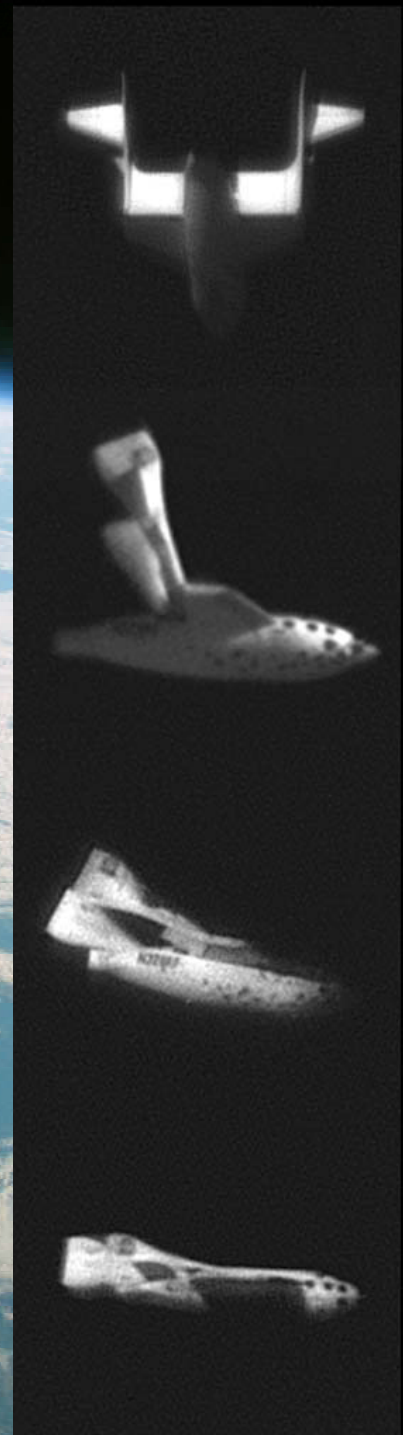
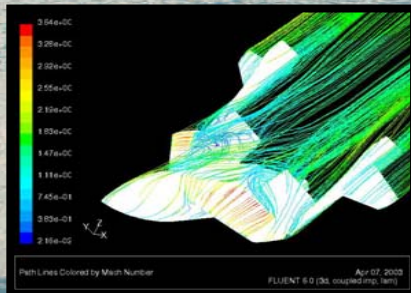


# The Re-entry Feather

Immune to accidents caused  
by entry flight controls

Forces Ship to a Stable High Alpha Condition  
Active controls not needed

- High Drag = Lower loads & Lower Heat
- Result: 'Care-Free' atmospheric entry





# An Aggressive Flight Test Program



- White Knight , Pre-Spaceship
  - Performance, Stability & Space Systems Development
  - 56 flights, 10 Months
- Rocket Hot-Fire Ground Tests
  - R & D - nine months, eleven firings
  - Flight qualification - Three Firings
- SpaceShipOne Flight Tests
  - Two captive carry (one manned)
  - Glide tests - 7 glides, 4 months
  - Rocket Powered Envelope Expansion – 4 flights, last one >100km
  - X-Prize – 2 full-performance flights in 5 days





# Space flight really **is** too dangerous

## Airline experience as a model

### Risk statistics, fatal risk per flight

- All manned space flight = 1 per 66 flights
- First airliners (1927 & 1928) = 1 per 5500.  
Same aircraft, but add some maturity (1933 to 1935) = 1 per 31,000
- Modern airlines = 1 per several million
- Logical Public Spaceflight goal:
  - Better than the first airliners
  - < 1% of the historic government space risk
  - Achievable only for sub-orbital

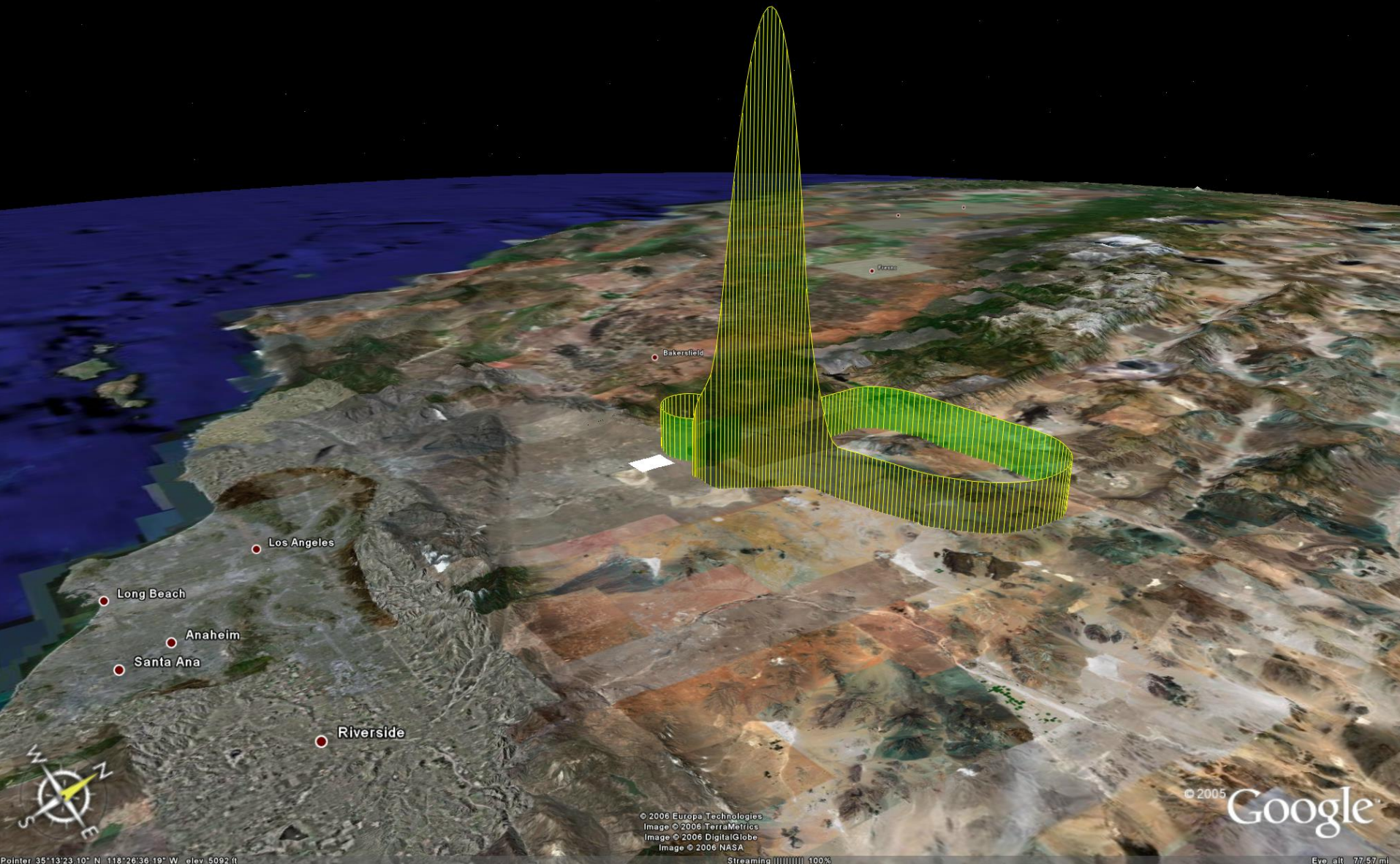
# Is a New Space Renaissance Possible?

## What Is Needed?

- **Environment that existed for aircraft in 1909**
  - Entrepreneurs in competition for market share
  - Belief that “I can do that”
- **Courage to try risky concepts**
  - Breakthroughs needed for safety
  - Robust solutions needed
- **Research justified by exploration and fun**
  - Not just politics and ‘science’



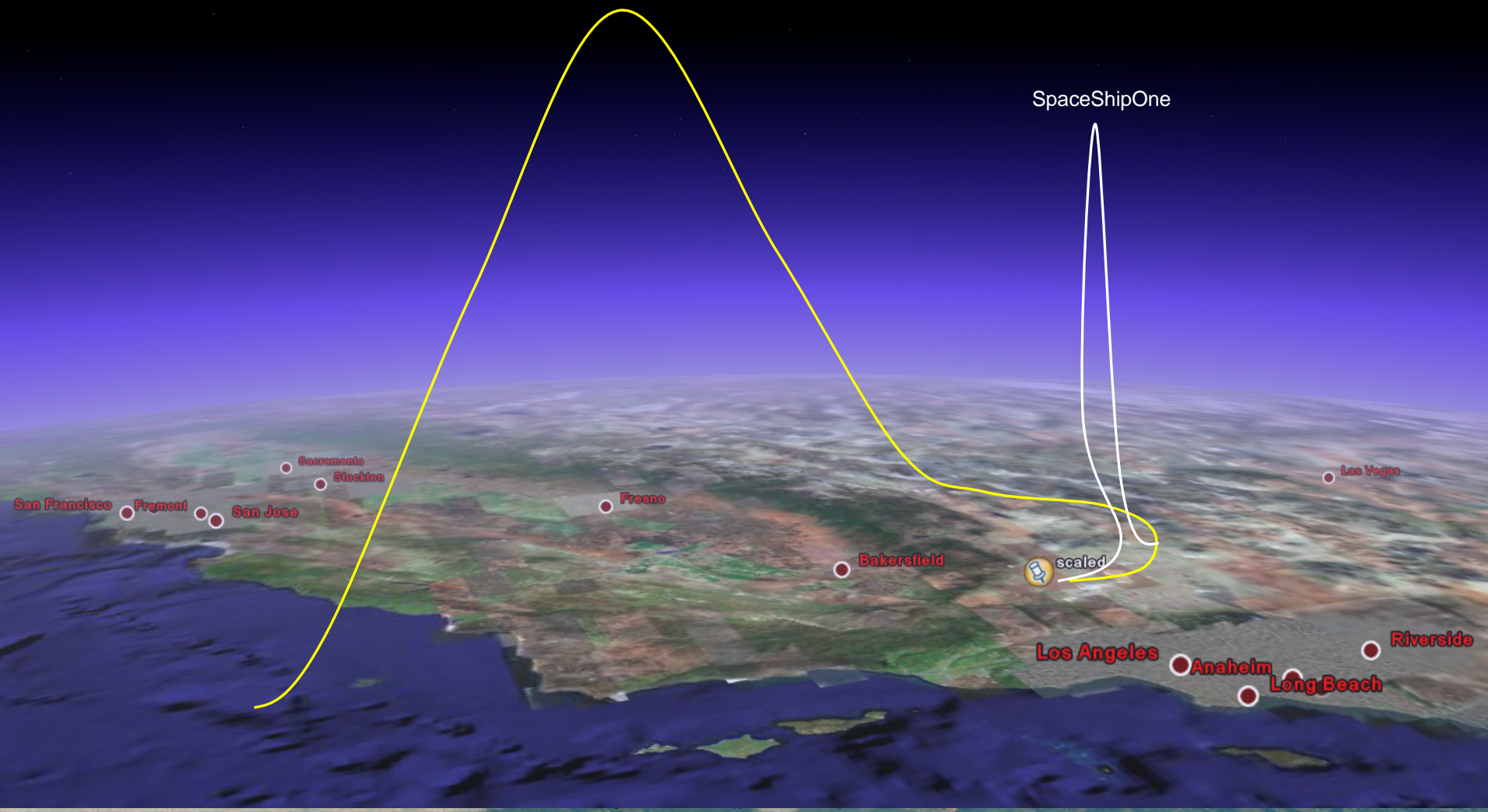
# Your View from 130 Km altitude – Mojave Desert



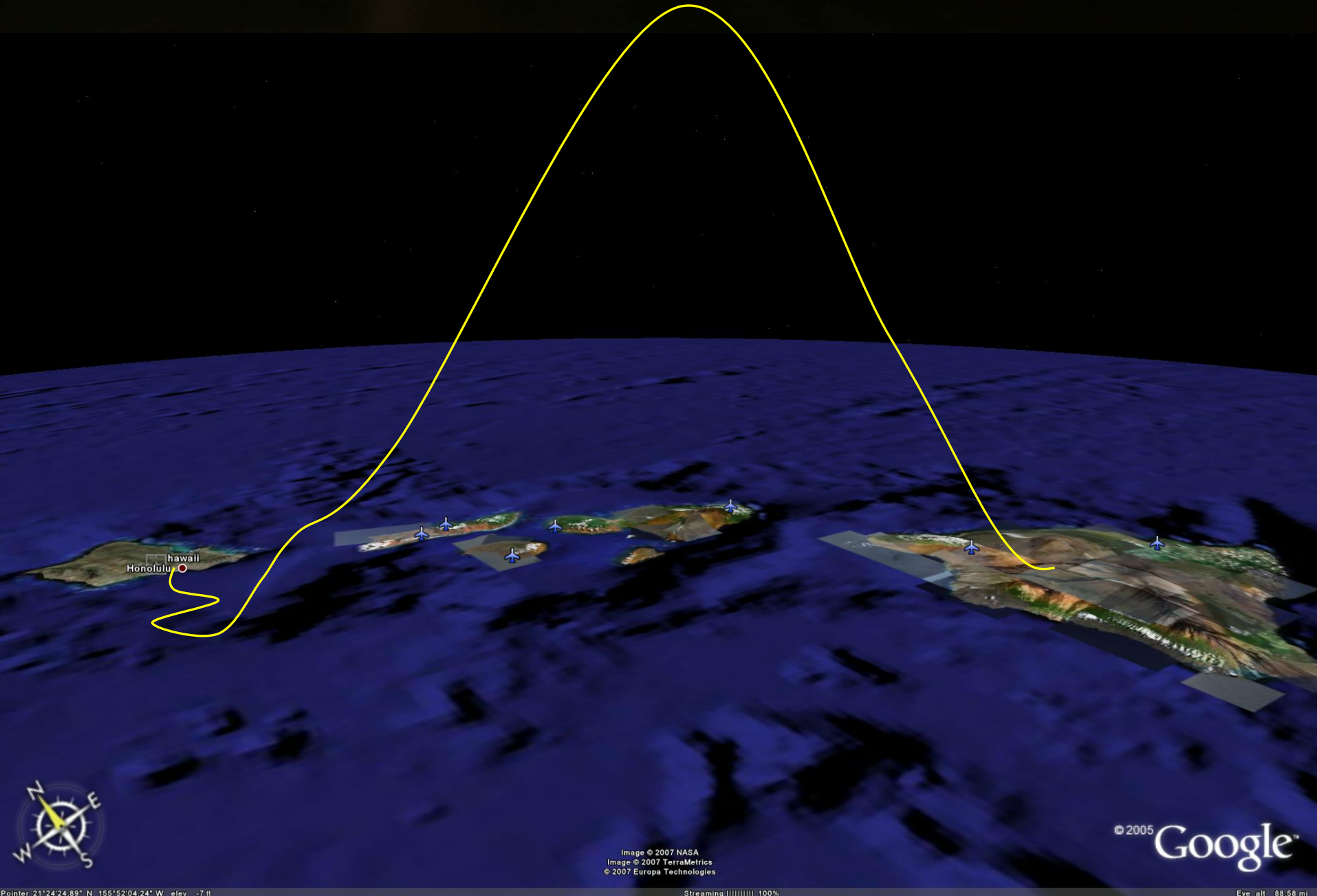


# Trajectories

## Commercial SubOrbital Private Spaceflight



See the Islands from a different perspective....



Hawaii  
Honolulu

Image © 2007 NASA  
Image © 2007 TerraMetrics  
© 2007 Europa Technologies

© 2005 Google

Pointer: 21°24'24.89" N 155°52'04.24" W elev. -7 ft

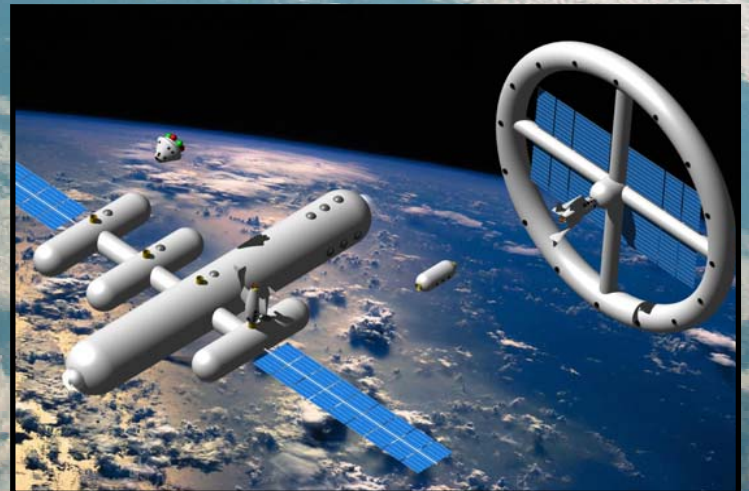
Streaming 100%

Eve alt. 88.58 mi

# The Next Steps for Private Spaceflight

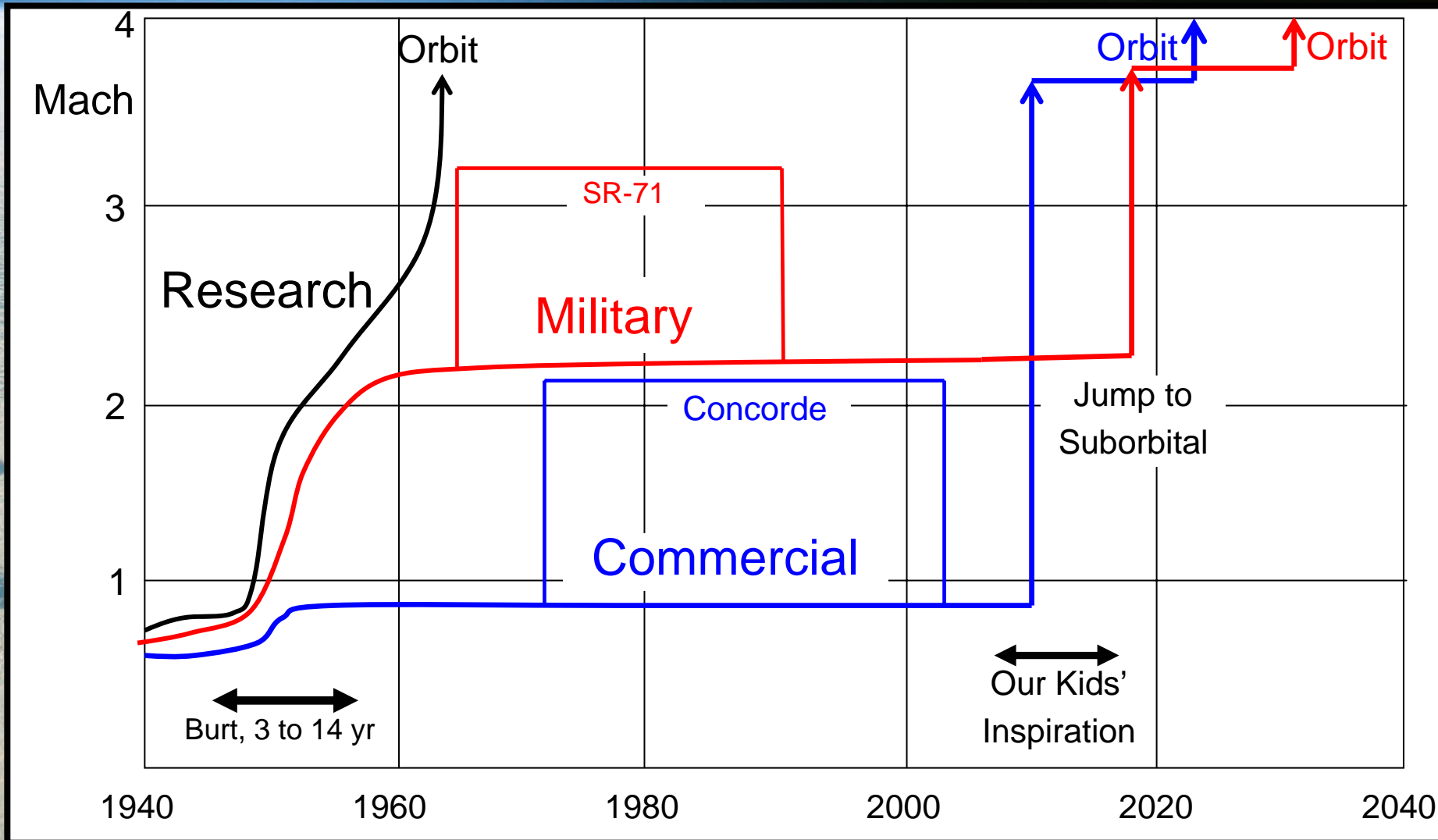
- First industry - sub-orbital flights
  - Experience – optimized
    - Large cabins, large windows and body weightless float.
- First industry - high-volume
  - Competing spacelines, flights priced to fly 100,000+ people (first 12 years of operations)

Success will accelerate solutions for safe, affordable flights to orbital resort hotels





# A Prediction Commercial Jumps Ahead of Military



# What Good is a Private Sub-orbital Space Industry? Just for Fun?

- The home computer – Internet example
  - ‘Fun’ really **is** defensible
- Inspiration for kids
  - Today’s technology products are enablers, not goals
  - Kids need to be inspired by a far-out dream/goal

# Why we stopped flying SpaceShipOne





# Your request to a non-expert....

## Rutan's Comments on S & T Focus for Defense?

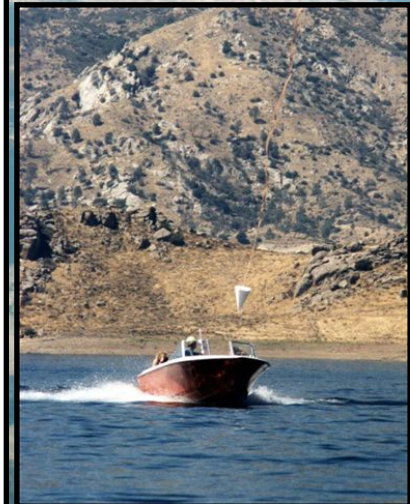
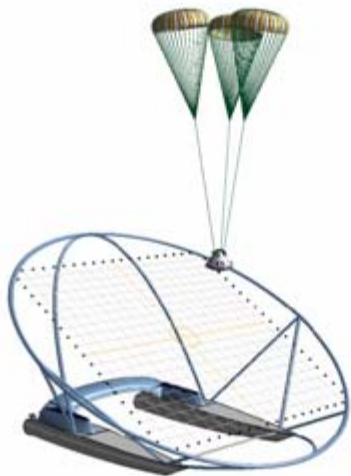
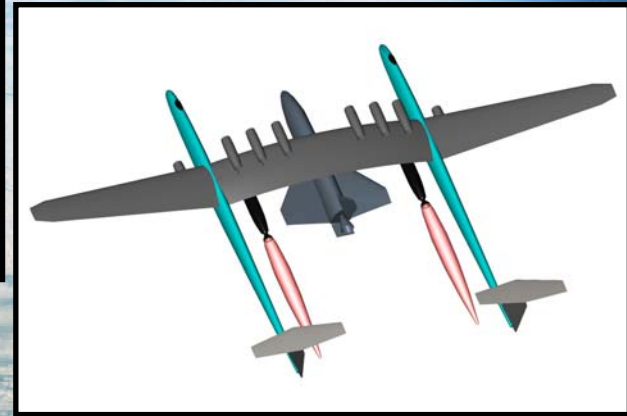
- U. S. competitive position in Science and Engineering.
- True responsive space presence.
- Heavy transport.
- The “all UAV Air Force”.
- Human contribution to global warming.
- Humanity's future in a connected world.

# U. S. competitive position in Science and Engineering

- The education statistics are bleak
  - Science vs. lawyers/media/politicians/actors\*
- \* And other criminals
- The real reason – we are boring our youth
  - Development vs. research
- The solution – take real risks
  - Exploration
  - Adventure
  - Breakthroughs
- Strive to be great, not to be ‘equal’

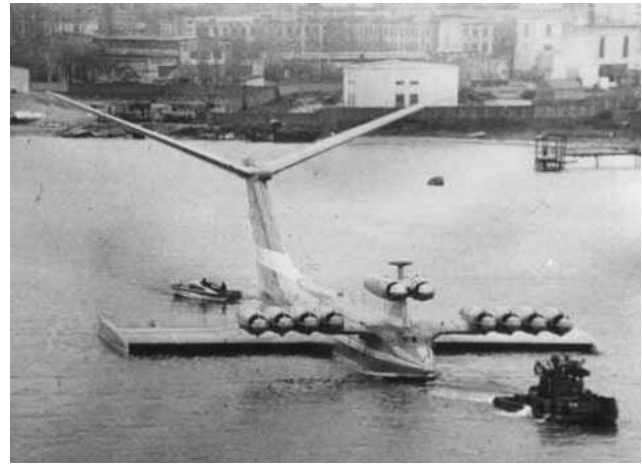
# True Responsive Space Access

- Air launch
- Routine, high-volume operations
- Sea recovery



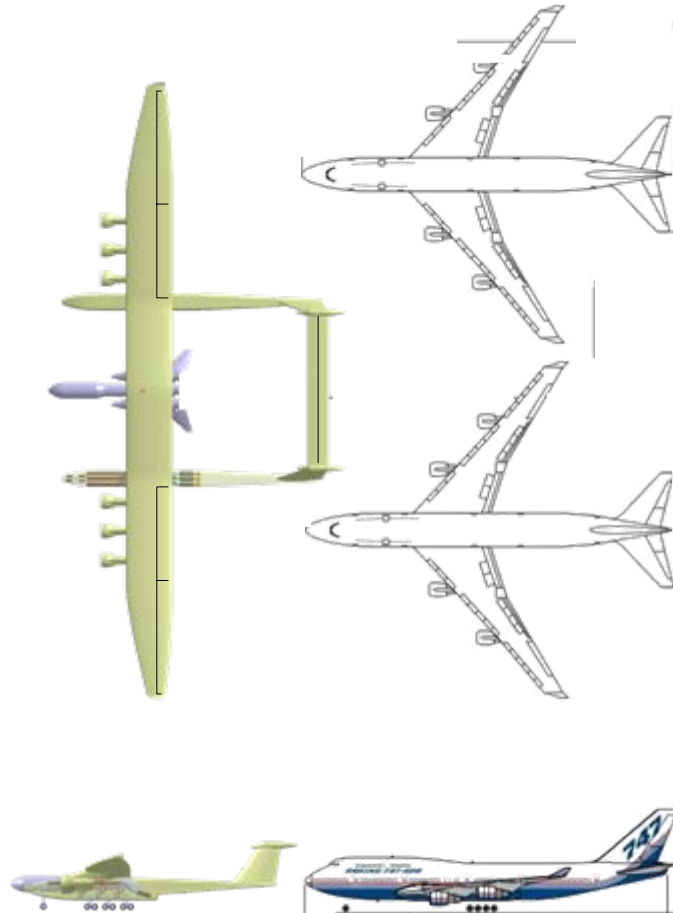


# Russian Ekranoplans (wing-ships)



# Heavy lift via use of a large space launcher

## Payloads up to 450klb



# UAV vs. Manned Aircraft Systems

- The fighter pilot's proficiency
  - Our leadership maintained?
  - Proliferation
- The fighter pilot's courage
  - Eliminate Capt Scott O'Grady?
- Cost savings?
  - Development and Ops

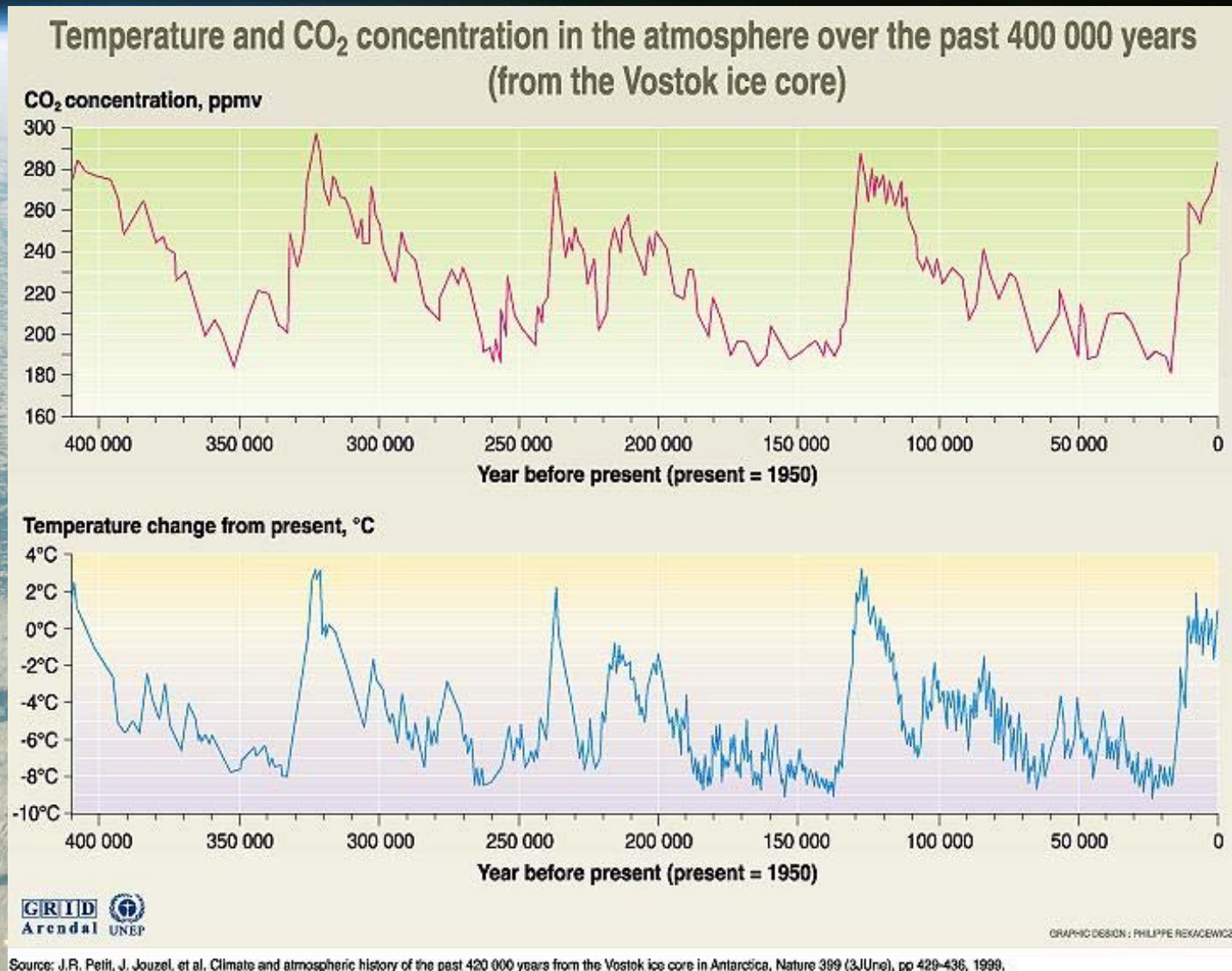




# Are we destroying the planet?

Consensus vs. Science

Technical solutions follow technical measurement



# Humanity's future in a connected world

- Internet....the tip of a huge iceberg
  - Our need to travel, if a virtual mode is available
  - Countries – defined by belief, not by geography
- Humanity – we are just getting started

# Pacific Theater Operational Science and Technology Conference

## ***Future Solutions - ISR***

April, 2007

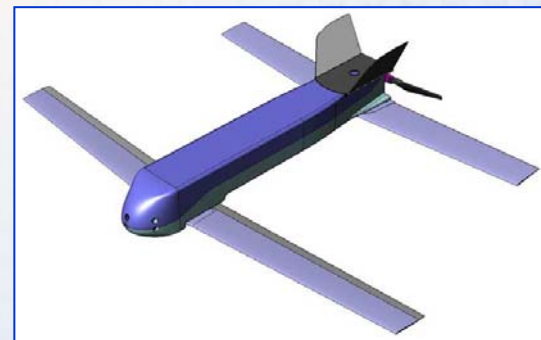


**John Grabowsky**  
**Executive VP, GM UAS**  
**AeroVironment, Inc.**

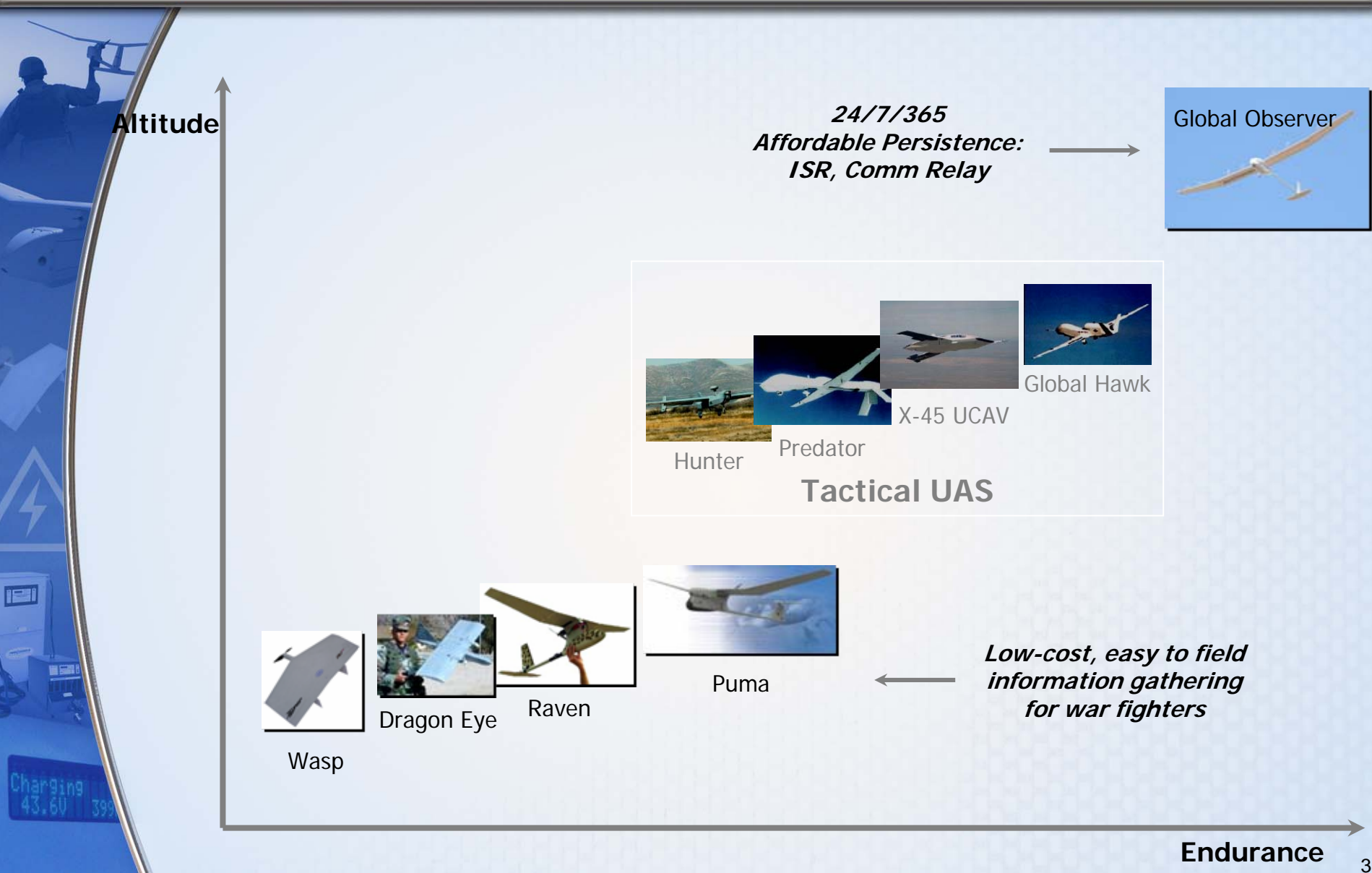


# Three New Platforms & Supporting Technologies

- Stratospheric ISR
  - Global Observer
- Squad-Level ISR
  - Wasp
- ISR, with teeth
  - Switchblade



# AV's Operating Space

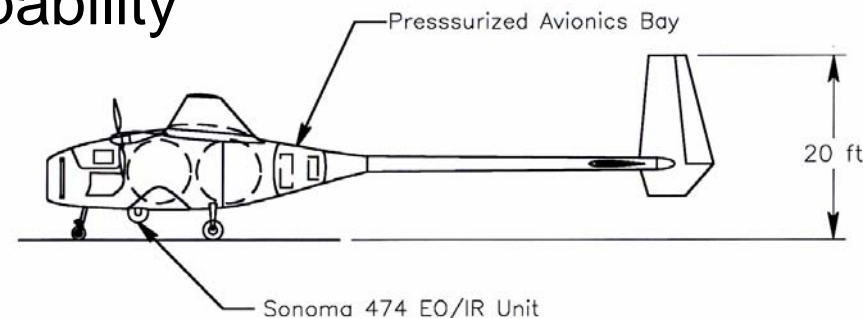
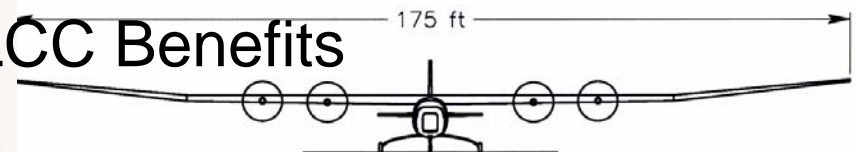
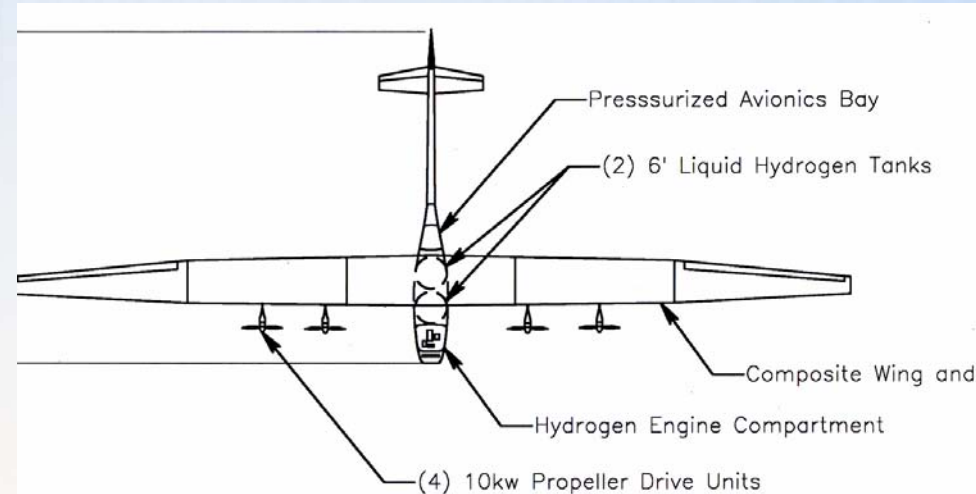


# Value of Affordable Stratospheric Persistence

- Quick Reaction
  - In/out theater Bandwidth
  - Comm Relay
  - ISR
  - Psy Ops
  - Disaster Recovery

- Compelling O&M and LCC Benefits

- Ability to “Reconstitute Capability”







*Pathfinder-Plus*



*Centurion*



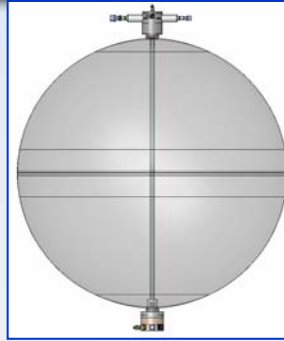
*Helios*



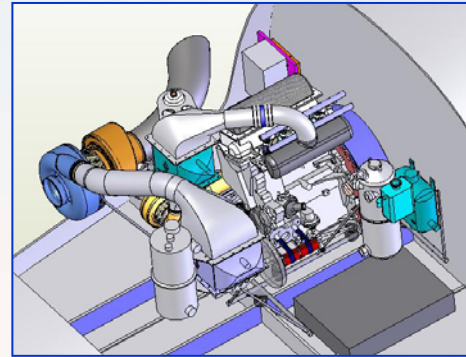
# Underlying Technologies

## GO-0 Flights

- LH<sub>2</sub> Tank



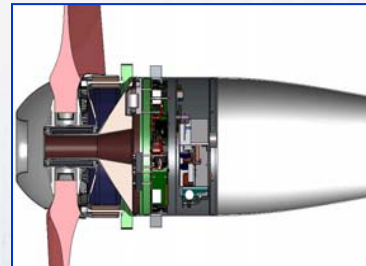
- LH<sub>2</sub> Powerplant



- Efficient Electric Generator



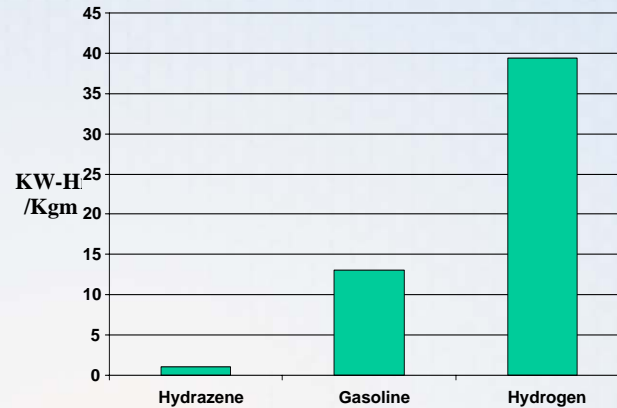
- Efficient Propulsion



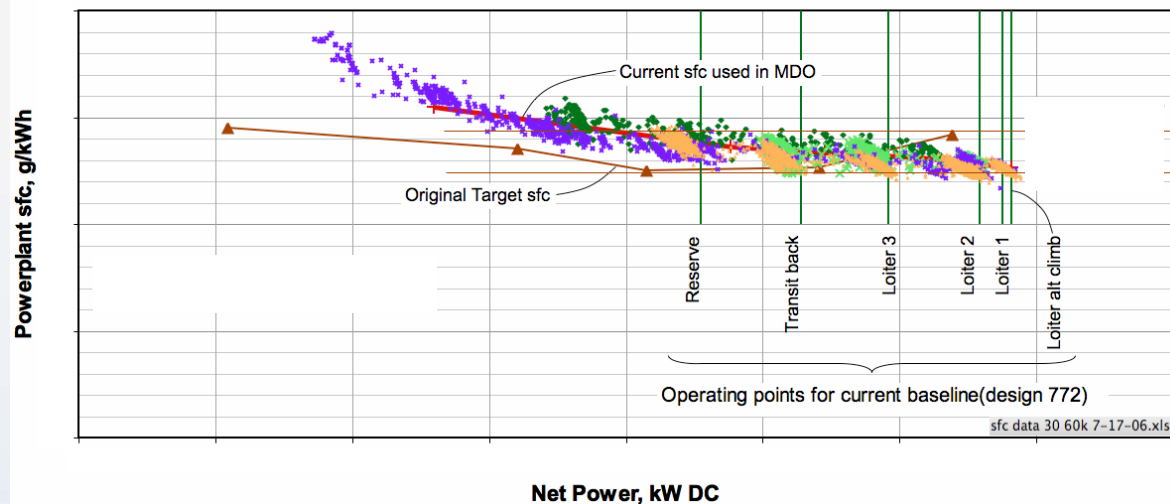
# Energy Densities and Efficiency

- Why Hydrogen?
- Specific Fuel Consumption

Specific Energy of Potential

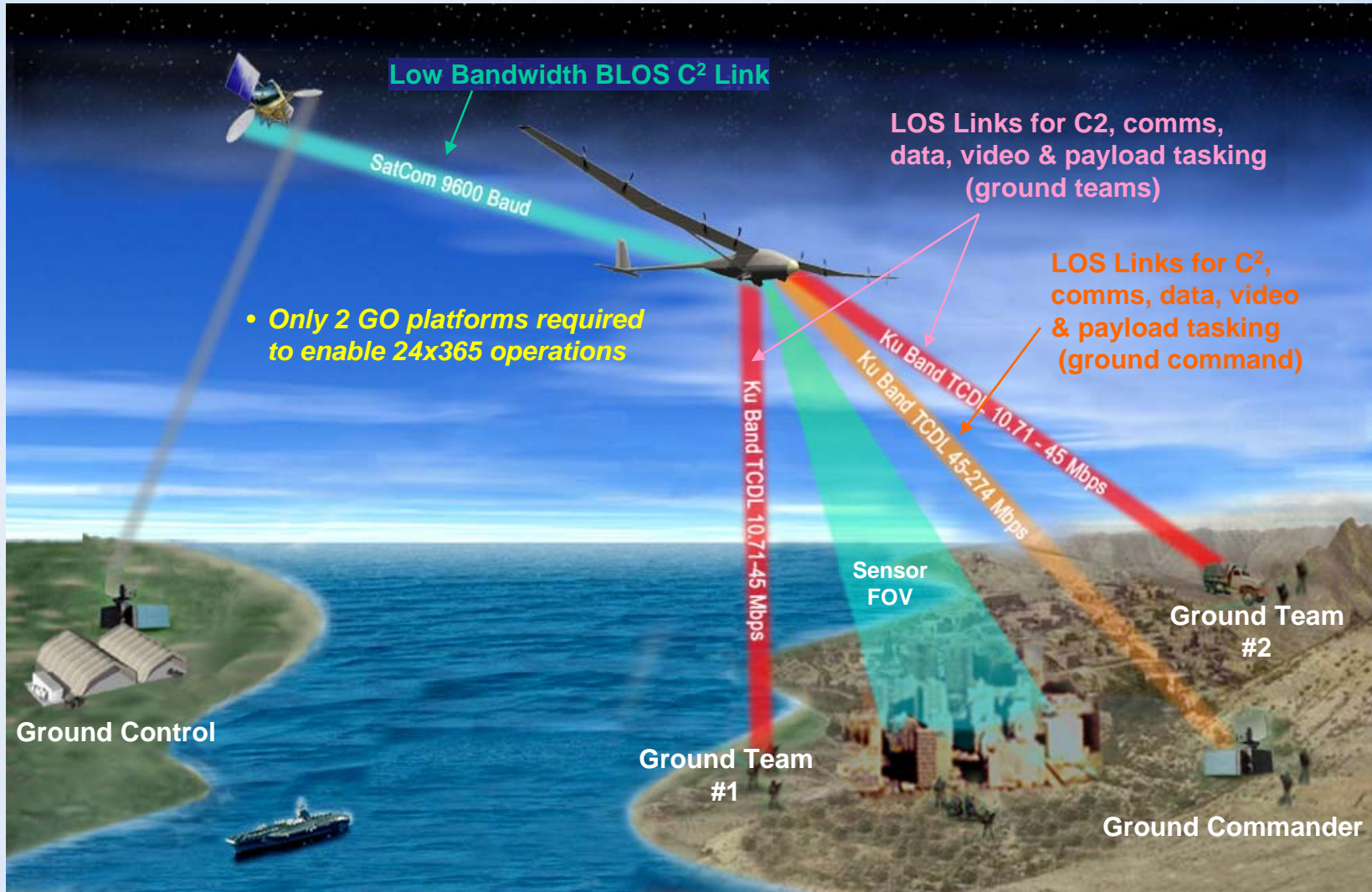


Efficiency at 65k ft based on net dc output power (after ancillaries)





# Military ISR and Relay Mission





Continuous (24/7/365) persistence over any point in footprint with 2 aircraft



# Squad-level ISR: Wasp





# Requirements for Squad ISR

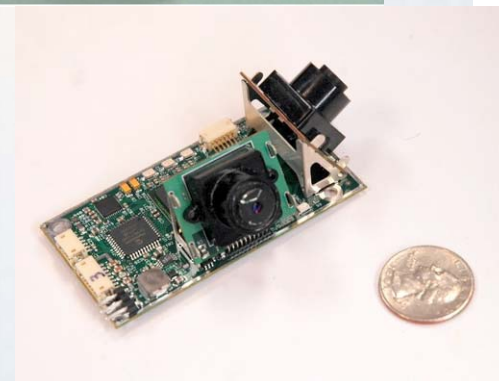
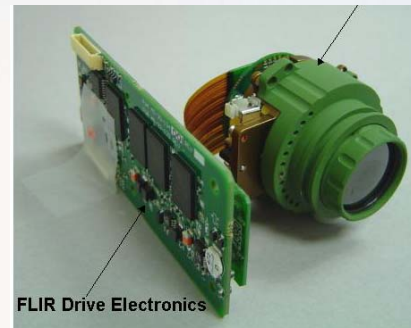
- Small, Lightweight, *System* Rucksack-portable
- Day and Night sensors
- 30+-minute endurance
- Rugged, Reliable
- Low cost
- Low-Observables

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

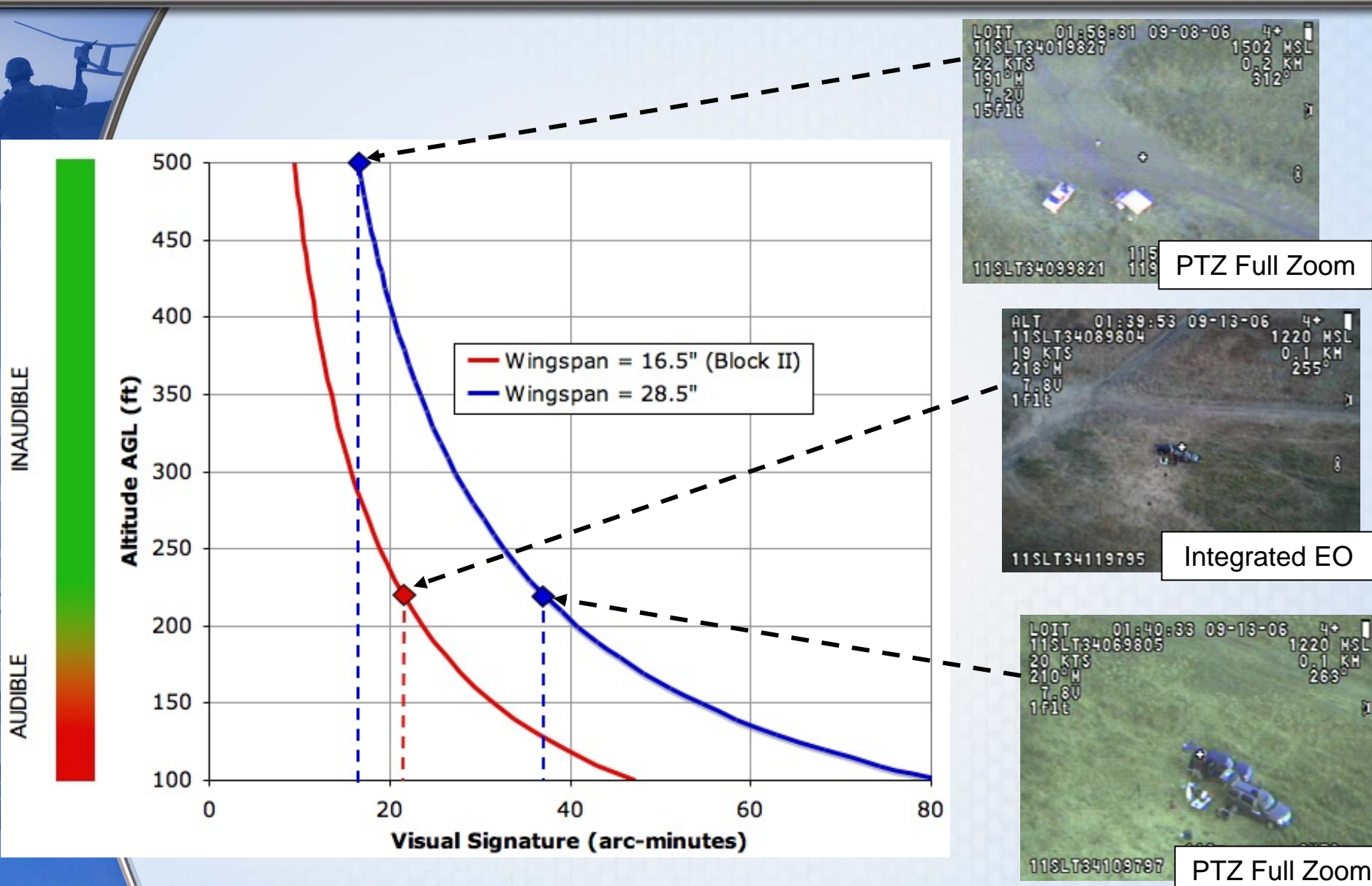


# Supporting Technologies: Payloads

- Electric Propulsion
  - Rugged
  - Quiet
  - Efficient
  - Inexpensive
  
- IR Payload
  - LWIR
  
- EO Payload
  - Digitally stabilized
  - Steerable

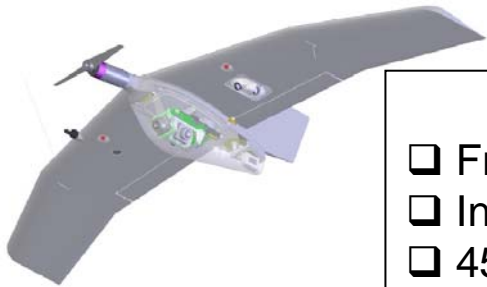


# Visual/Acoustic Signatures and Resolution





# Wasp Block III Configurations

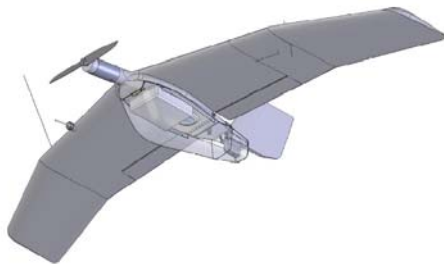
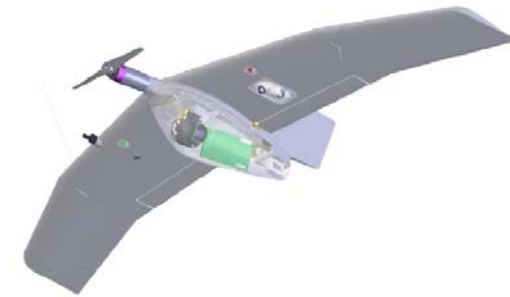


## Daytime Wasp

- ☐ Front/side imager, digital image stabilization and pan-tilt-zoom
- ☐ Integrated dual EO payload
- ☐ 45-minute endurance

## Nighttime Wasp

- ☐ Thermal imager
- ☐ Integrated dual EO payload
- ☐ 40-minute endurance



## Long Endurance Wasp

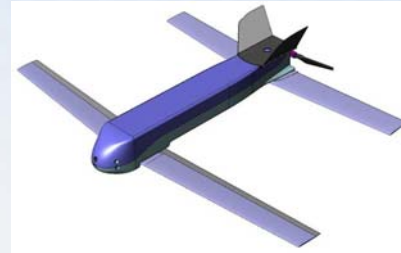
- ☐ Extended endurance battery pack (double the capacity)
- ☐ Integrated dual EO payload
- ☐ 100+ minute endurance calculated

# Man-portable ISR, with teeth: Switchblade

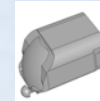


# Squad-level Lethal UAV Requirements

- Man-Portable SYSTEM
  - Air Vehicle
  - Launcher
  - GCU
- Low Optical/Acoustic Signatures
- High Speed
- Autonomous Terminal Guidance
  - Small CEP
- Warhead
  - Lightweight
  - Lethal
  - Minimal Co-lateral
- Low Cost per round



**Air Vehicle**



**Warhead**



**Launcher**

**Raven/Wasp  
GCU**



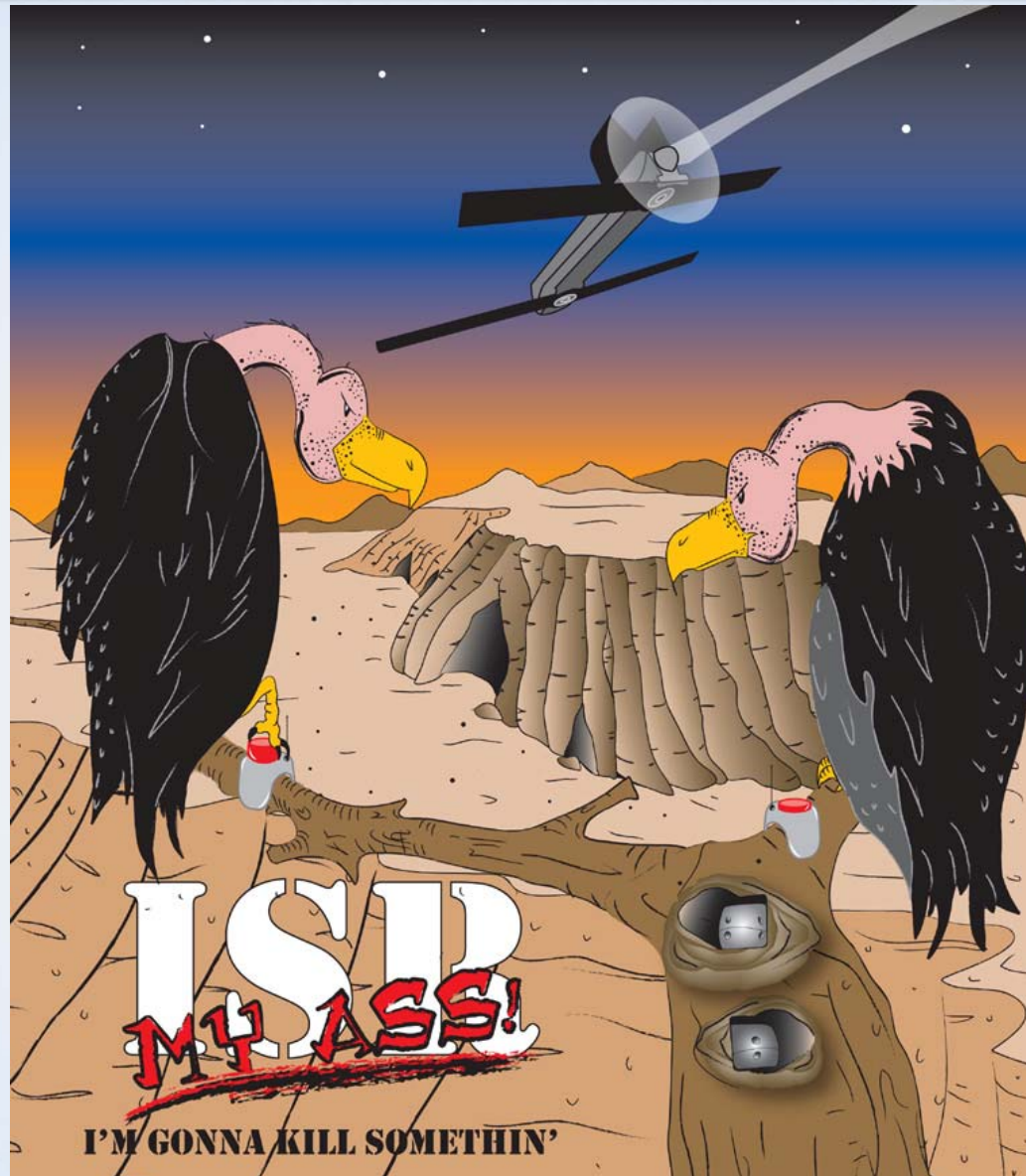


- 
- A vertical decorative sidebar on the left side of the slide. It contains several blue-tinted icons: a person in a flight suit holding a remote control, a small aircraft, a propeller, a lightning bolt, a battery, and a digital display showing 'Charging 43.6V 399'.

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.



# The End





Aligned with your needs.

# Pacific Operational Science and Technology Conference Panel Discussion Undersea Warfare

Mr. Roger Bagbey  
Senior Vice President, Engineering Technology Center  
Alion Science and Technology Corporation

4 April 2007





# USW Panel Agenda

- NDIA Undersea Warfare Division
- Basis for Industry Meeting PACOM's Needs
  - Knowing What's Needed for USW
  - Opportunity for Return on Investment
- An Example
- Summary





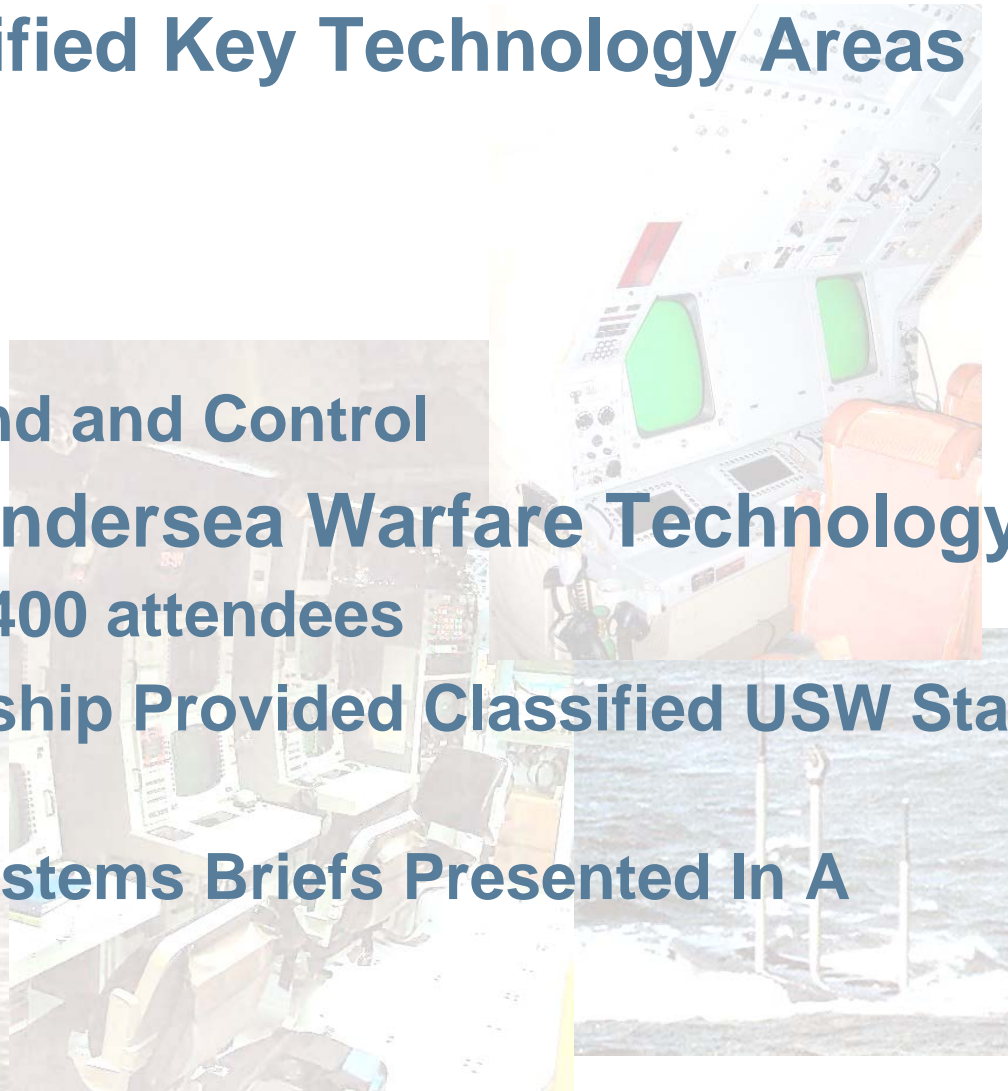
- **The USW Division defines Undersea Warfare as:** Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Surveillance, and Special Operations
- **Organized into five focus areas:**
  - Sensor Systems, Mine Warfare (MIW) Systems, Undersea Vehicles, Aviation, and C4I and Combat Systems
- **Sponsors Two Major Technical Conferences**
  - Joint Undersea Warfare Technology Spring Conference
  - Joint Undersea Warfare Technology Winter Conference
- **Currently Conducting Two Technical Studies for USN Sponsors**
  - ASW Common Tactical Picture Study, 8 June 2006- in process
  - Distributed Netted Sensor Study, 6 January 2006 – in process





## Overview of USW Division

- **USW Division Identified Key Technology Areas**
  - Deployment
  - Sensing
  - Communications
  - Distributed Command and Control
- **2007 Spring Joint Undersea Warfare Technology Conference - About 400 attendees**
  - Senior Navy Leadership Provided Classified USW Status and Concerns
  - 126 Program and Systems Briefs Presented In A Classified Forum





# Basis for Industry Meeting PACOM's Needs

- **Knowing What's Needed**

- Threat
- Operational Constructs
- Constraints
- Challenges



- **Opportunity for Return on Investment**

- Availability of funding
- Protection of Intellectual property
- Timeliness of Return





# Knowing What's Needed for USW Beyond 2010

- **Science & Technology**

- DARPA
- ONR (BAA, SBIR, STTR, FNC, etc.)
- NDIA (Bi-Annual Conferences, Special Studies)
- NRAC, NSB (Special Studies)
- Etc.

- **System Development**

- PEOs/SYSCOMS
  - Performance (System) Specific RFP
    - Formal Acquisition Process
  - Directed BAA
    - e.g. Theater ASW, Periscope Detection Radar

- **Navy Master Plans (ASW, MIW, UUV, ...)**





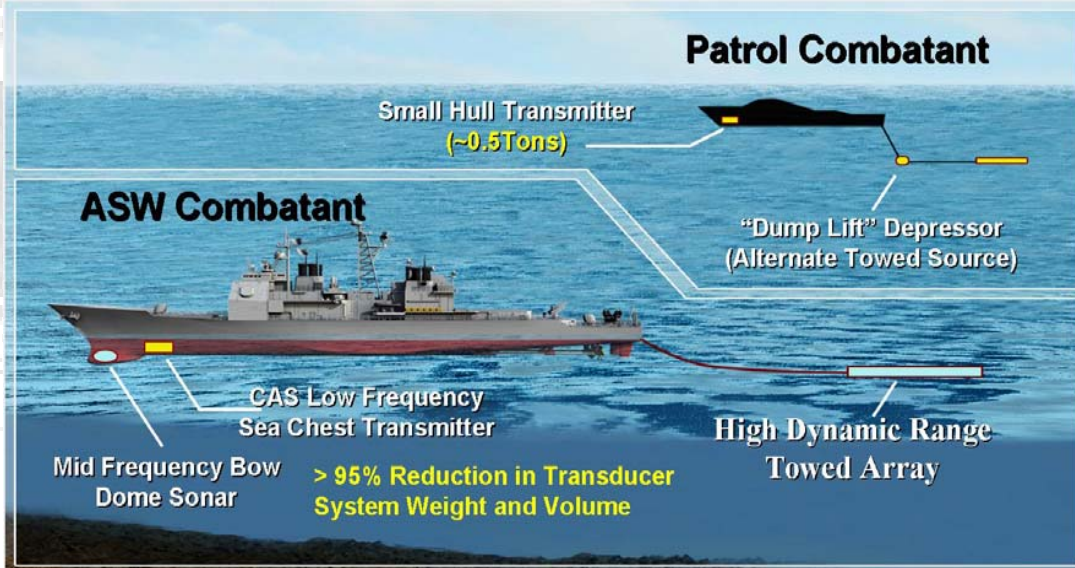


# Opportunity for Return on Investment

- **Availability of Funding**
  - General Decline Known & Accepted
  - PBD 753 Augments ASW R&D
- **Protection of Intellectual property-Versus:**
  - Peer Reviews
  - Open Sourcing
- **Timeliness of Return on Investment**
  - Rapid Development Concept  
versus
  - Business as Usual



# An Example from Alion Experience: Continuous Active Sonar (also Receive While Transmit (RWT))



## What is it?

- High Dynamic Range Electronics permits receiver cancellation of directly transmitted signal without disturbing echo reception
- Radar heterodyning technique converts continuous echo to narrowband signal with frequency proportional to range

## How does it work?

- More Energy on Target With Less Power (Smaller, Low Impact, Transmitters)
- Increased Time x Bandwidth Product (Lower Detection Thresholds)
- Narrowed Track Gates (Better Range Rate Resolution; Reduced Clutter)
- Enables Many Implementation Concepts (Ship Based; Off-board, &

Distributed)

**Bottom Line: Longer Detection Ranges/Reduced Latency/Lower Cost**





## USW Discussion Summary

- NDIA has a functional and focused structure and its members remain anxious to support PACOM's USW Needs
- Funding Limitations are a fact of life that Industry accepts
- Industry's ability to innovate is conditioned by DoD policies, e.g. Security, Peer Review , Open Sourcing , and Acquisition Timeliness

**Industry can meet DoD S&T needs and welcomes more direct warfighter interaction**



Aligned with your needs.

# Questions and Comments



# Maritime Domain Awareness – *Future Industry Solutions... FY10 and Beyond*

Tom Williams

4 April 2007



# The Challenge

*Conventional Warfare*



*Global War on Terror*



*Forward Presence*

*"We Need a NORAD for Maritime Forces"*

*Admiral Vern Clark, Former CNO*

*(August 15, 2002)*

**NORTHROP GRUMMAN**



# The Problem

- *Over 150,000 commercial ships*
- *80,000 involved in global trade*
- *40,000 ships within 1,000 mi of US coastline*



# Enabling Technology Investment Areas

- 
- *Ability To Uniquely “Fingerprint” Thousands of Large and Small Hull Commercial Ships*
  - *Fusion and Reasoning Tools*
  - *Persistent Surveillance*
  - *Cooperative Communications / Information Sharing*

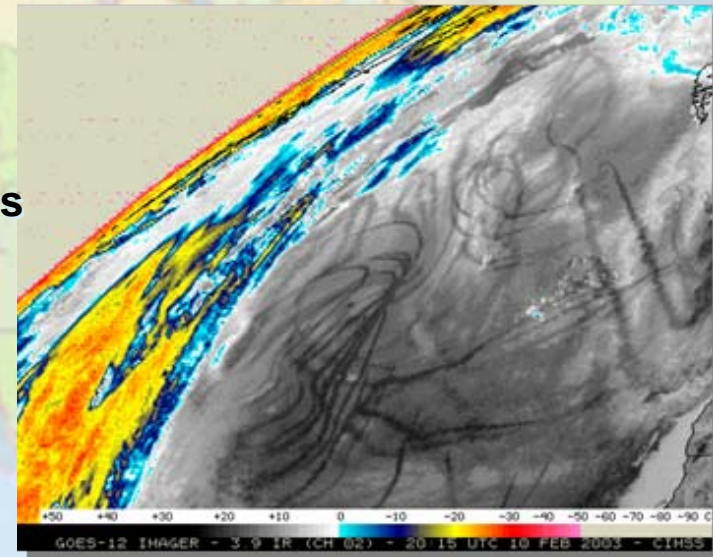


# "Finger Printing"

- AIS (Automatic Identification System)
- EO/IR
- Radar/Radar Emissions
- Acoustics
- Hyperspectral
- Other Unintended Emissions



- Less Uncertainty
- More Targets
- Greater Ranges
- Bearings and Tracks



*"Knowing Who's Who with Certainty"*



# Fusion and Reasoning Tools/Algorithms

- Behavior Analysis / Pattern Recognition
- Netted and Shared Information

*NOA: Ship, Voyage, Cargo, Crew*

*NOA: INFO, Criminal Data Bases Other Intelligence*

*Track Files*

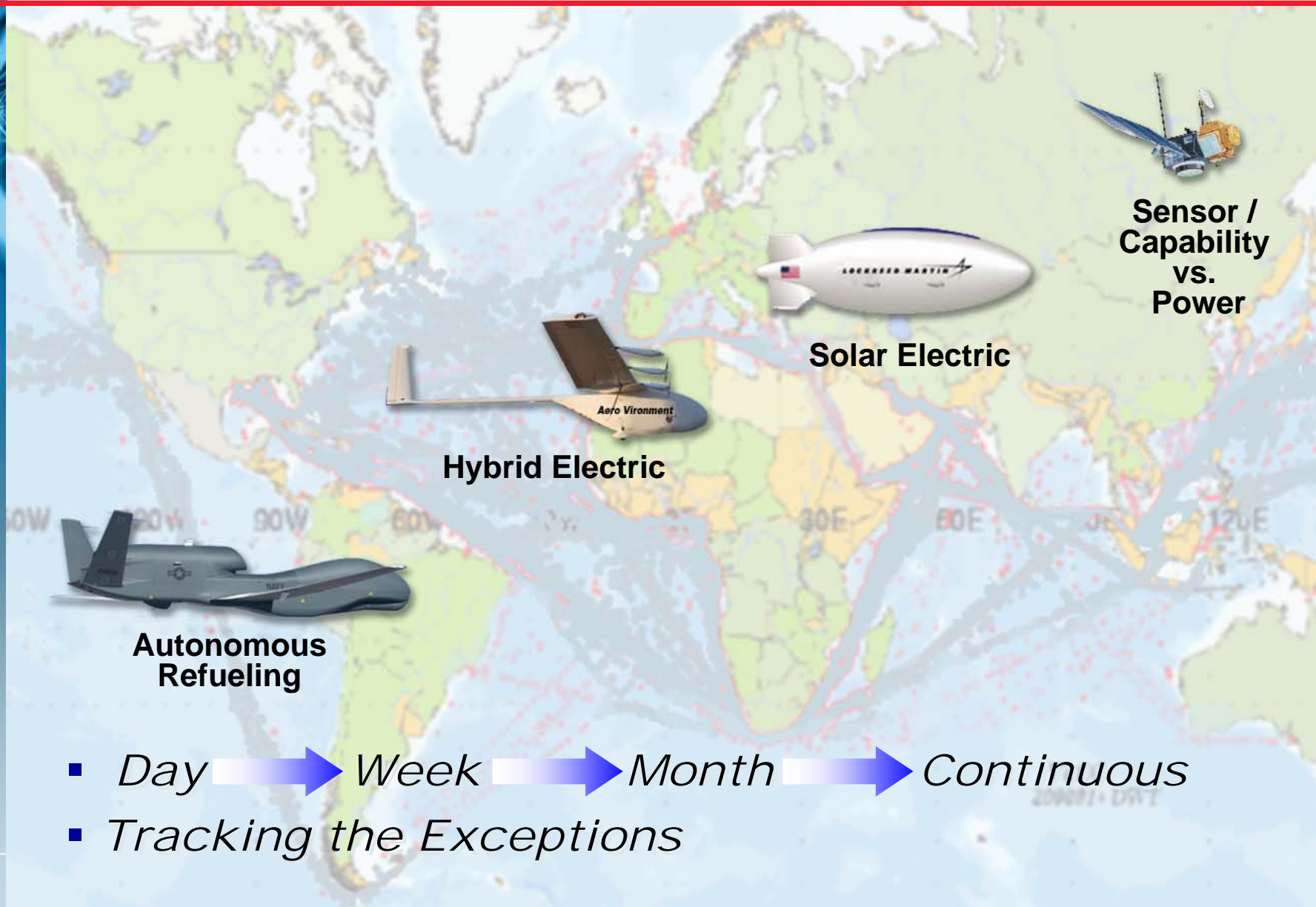
*Ship and Company Data Bases*

*AIS Info*

*Port Data Bases*

- *"Clutter Rejection"... Weeding Out the Good Guys*
- *Knowing Where Your Ship Has Been Lately?*


# Persistent Surveillance





# Cooperative Communications / Information Sharing

- Linking dissimilar systems together cost effectively... Today today
- Assured Comms

- 
- *"Pay for it only when you need it"*
  - *Seek options which provide interoperability / netcentricity now, and... enable affordable transition to standards / common systems*



# Enabling Technology Investment Areas

- 
- *Ability To Uniquely “Fingerprint” Thousands of Large and Small Hull Commercial Ships*
  - *Fusion and Reasoning Tools*
  - *Persistent Surveillance*
  - *Cooperative Communications / Information Sharing*

# Duck Hunting Made Easy



**NORTHROP GRUMMAN**

DEFINING THE FUTURE





# ***Intelligence Perspective U.S. Pacific Command***

***3 Apr 2007***

***RADM Andy Singer  
USPACOM J2 &  
Director, Joint Intelligence  
Operations Center***





# Integrate Intel, Ops & Plans

- Set conditions for success ... 2/3/5 unified action
  - Includes operational perspective and 'So What' factor
  - Links ops to future planning
- 'Always On' dynamic Intel interaction
  - Increases 2/3/5 situational awareness and info sharing 24/7
  - Shapes ops and plans ... influences decisions
- New Core Value
  - Know theory of victory – challenge with Intel
  - Clarity of data and Intel – not consensus of opinion
  - Quality of analysis
  - Blue – Red team



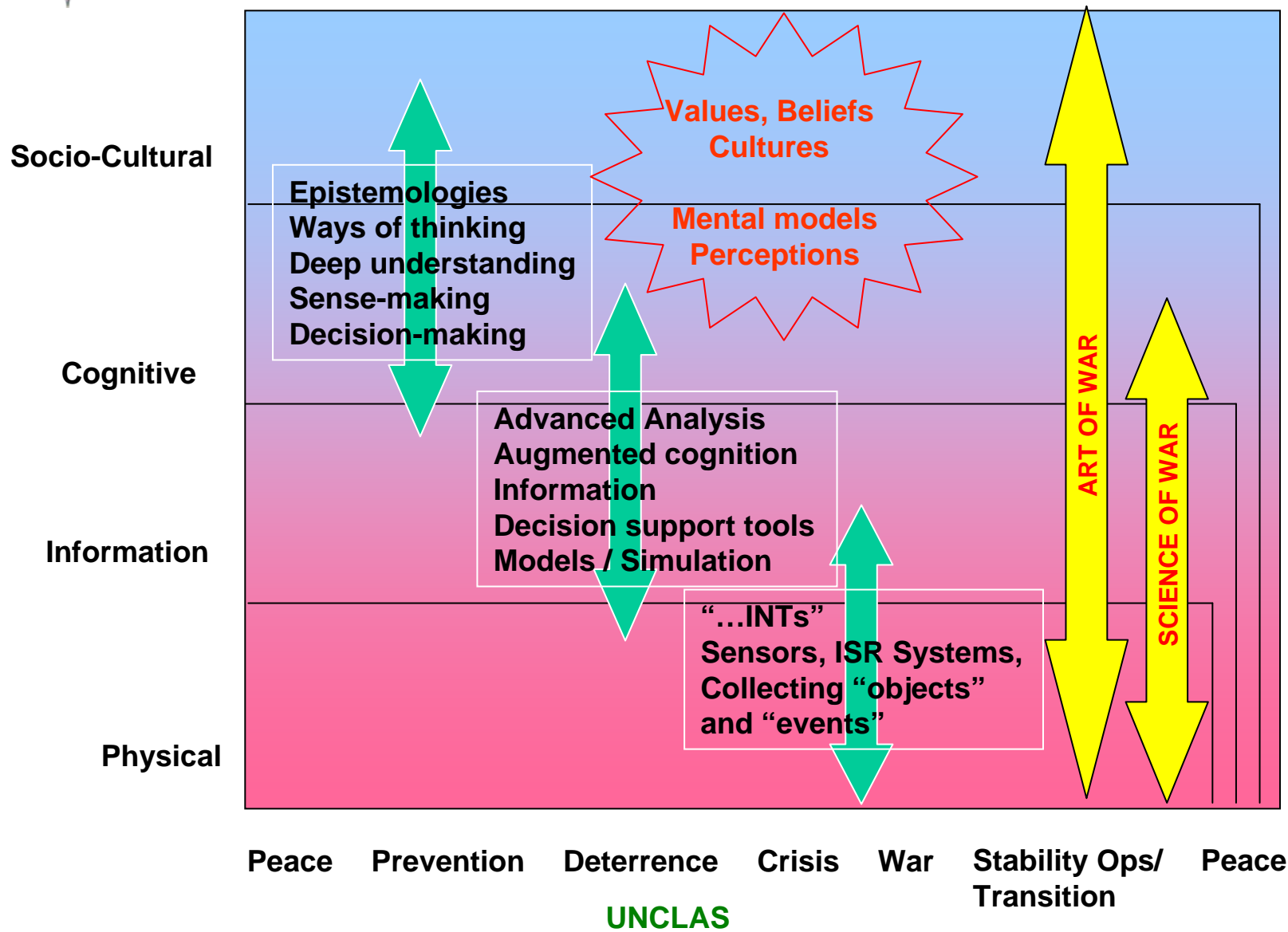
# Intel Mythology

1. Outside world cannot contribute to understanding Intel
2. It is about stealing secrets
  - Higher classification  $\neq$  better
3. Is a service + decision maker's master
4. All we need is horizontal integration
  - Vertical first
5. Intel Operators vs. mechanics

**So what do we do about it?**



# “Art and Science” / Domains of Warfare





# DHS Science & Technology: Alignment for Success

## Pacific Operational Science & Technology Conference

Honolulu, Hawaii • April 3, 2007

Jay M. Cohen  
Under Secretary  
Science and Technology Directorate



Homeland  
Security





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Security

Surprise is nothing new to Hawaii!



# DHS S&T Investment Portfolio

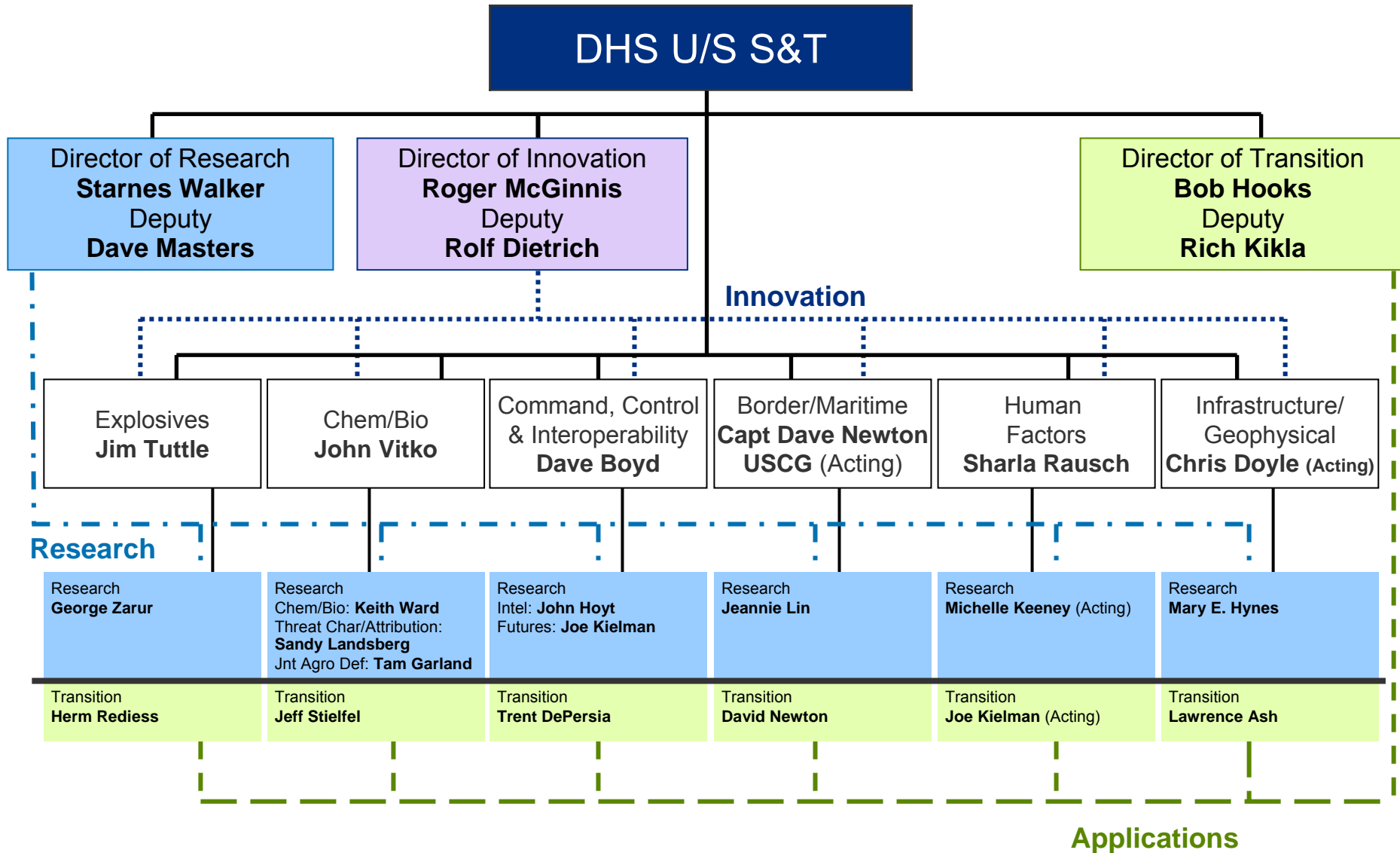
Balance of Risk, Cost, Impact, and Time to Delivery

<b>Product Transition (0-3 yrs)</b> <ul style="list-style-type: none"><li>▪ Focused on delivering near-term products/enhancements to acquisition</li><li>▪ Customer IPT controlled</li><li>▪ Cost, schedule, capability metrics</li></ul>	<b>Innovative Capabilities (1-5 yrs)</b> <ul style="list-style-type: none"><li>▪ High-risk/High payoff</li><li>▪ “Game changer/Leap ahead”</li><li>▪ Prototype, Test and Deploy</li><li>▪ HSARPA</li></ul>
<b>Basic Research (&gt;8 yrs)</b> <ul style="list-style-type: none"><li>▪ Enables future paradigm changes</li><li>▪ University fundamental research</li><li>▪ Gov’t lab discovery and invention</li></ul>	<b>Other (0-8+ yrs)</b> <ul style="list-style-type: none"><li>▪ Test &amp; Evaluation and Standards</li><li>▪ Laboratory Operations &amp; Construction</li><li>▪ Required by Administration (HSPDs)</li><li>▪ Congressional direction/law</li></ul>

**Customer Focused, Output Oriented**



# S&T Organization



# Transition Portfolio

*Enabling Capabilities, Supporting Mission Critical Needs of DHS*



## Integrated Product Teams (IPTs)

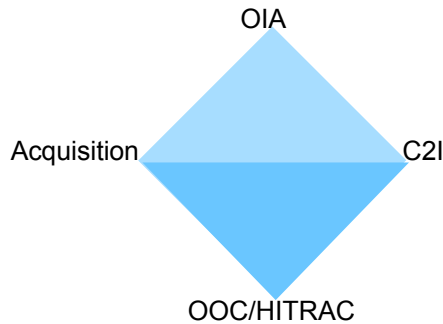
- 11 Capstone IPTs form the centerpiece of S&T's customer-driven approach to product transition
- Engage DHS customers, acquisition partners, S&T technical division heads, and end users in product research, development, transition and acquisition activities
- Identify our customers' needs and enable and transition near-term capabilities for addressing them



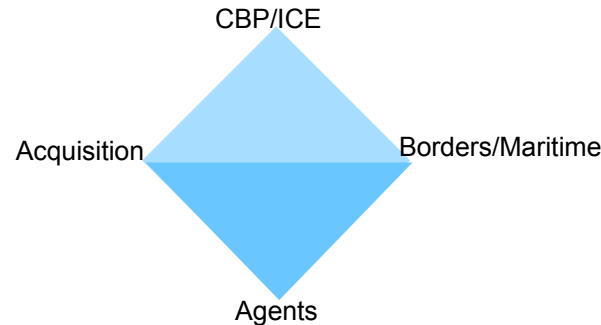
# DHS Requirements/Capability Capstone IPTs

DHS S&T Product – “Enabling Homeland Capabilities” (EHCs)

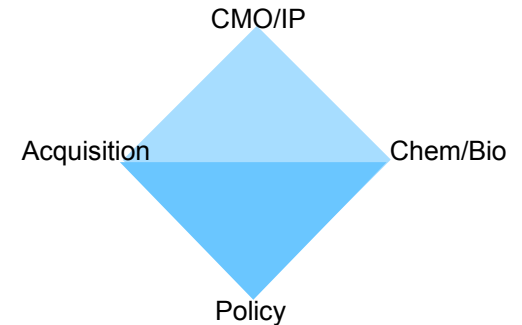
## Information Sharing/Mgmt



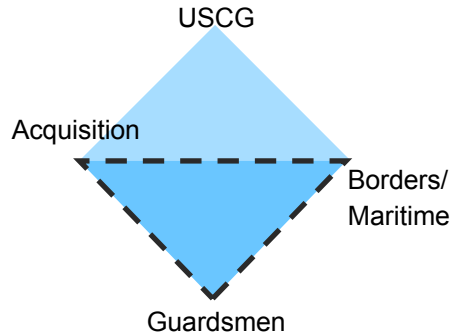
## Border Security



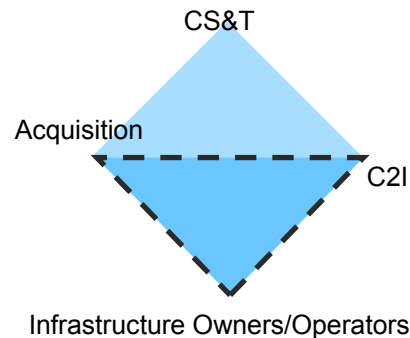
## Chem/Bio Defense



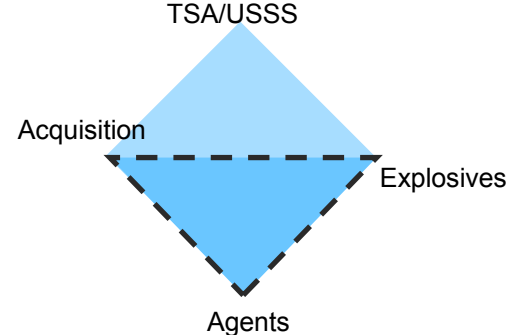
## Maritime Security



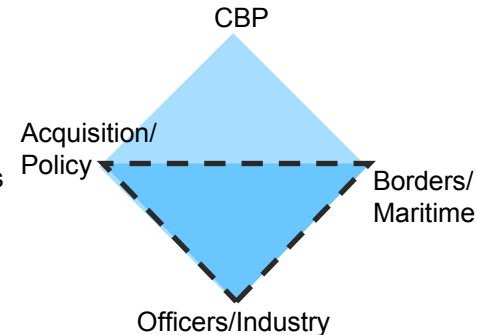
## Cyber Security



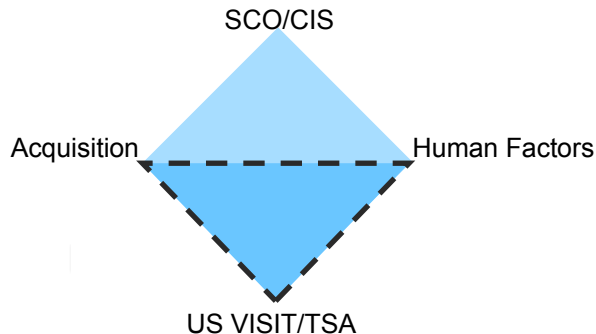
## Explosive Prevention



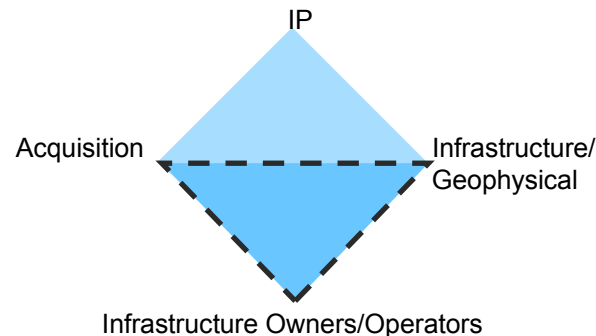
## Cargo Security



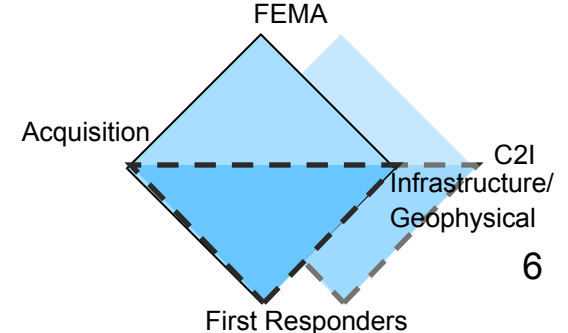
## People Screening



## Infrastructure Protection



## Incident Management



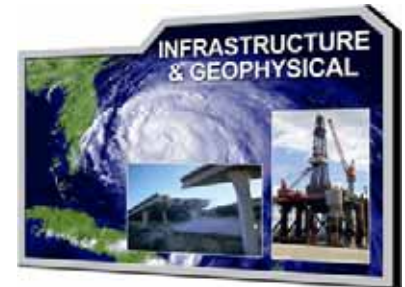


# Basic Research Portfolio

*Discovery and Invention to Enable Future Capabilities*



- Brings the capabilities, talent and resources of the Homeland Security Centers of Excellence, DOE National Laboratories and DHS Labs to bear to address the long-term R&D needs for DHS in sciences of enduring relevance
- This type of focused, protracted research investment has potential to lead to paradigm shifts in the nation's homeland security capabilities



# Homeland Security Act of 2002

HSARPA will....

“Support basic and applied homeland Security research to promote *revolutionary* changes in technologies; advance the development, testing and evaluation, and deployment of critical homeland security technologies; and accelerate the prototyping and deployment of technologies that would address homeland security vulnerabilities.”

**EVERY  
TRULY  
GREAT  
ACCOMPLISHMENT  
IS AT FIRST  
IMPOSSIBLE!**

(FORTUNE COOKIE)



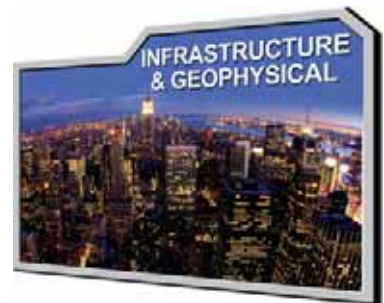
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# Innovation Portfolio

*High Risk, High Gain, Game Changers for Leap-Ahead Results*



- Promotes revolutionary changes in technology
- Focus on prototyping and deploying critical technologies
- Includes:
  - HSARPA – Homeland Security Advanced Research Projects Agency
  - “Homeworks” – 1% of budget highest risk, highest pay-off
  - Small Business Innovation Research program
  - Visit [www.FedBizOpps.gov](http://www.FedBizOpps.gov), [www.hsarpabaa.com](http://www.hsarpabaa.com) and [www.dhssbir.com](http://www.dhssbir.com)





# HIPS and HITS

**Homeland Innovative Prototypical Solutions (HIPS)** are designed to deliver *prototype-level demonstrations* of game-changing technologies in two to five years. Projects are moderate to high risk, with high payoff.

**High Impact Technology Solutions (HITS)** are designed to provide *proof-of-concept* answers within one to three years that could result in high-payoff technology breakthroughs. While these projects are at considerable risk for failure, they offer the potential for significant gains in capability.



# Homeland Innovative Prototypical Solutions (HIPS)

Explosives	Chem/Bio	Command, Control & Interoperability	Borders/ Maritime	Human Factors	Infrastructure/ Geophysical
<p><b>Project Chloe-</b> High altitude aerial platform existing above civil aviation Counter-MANPADS</p> <p><b>SENSIT –</b> System to identify numerous liquids in baggage</p> <p><b>IED Defeat / APE VBIED Defeat –</b> Detection/prevention and mitigation technologies to counter IEDs</p>		<p><b>SCOPE</b> (Scalable Common Operational Picture Experiment) – Leverages Global Observer JCTD</p>	<p><b>Scalable Composite Vessel Prototype (SCVP)</b> – Lightweight, composite material with high speed hull</p> <p><b>SAFECON</b> – 90 second container screening device</p>	<p><b>FAST M2</b> (Future Attribute Screening Technology Mobile Module) – Relocatable Lab capable of testing for behavioral/ physiological cues of “hostile intent”</p> <p>Double or triple wide trailer tested at various sites around the country</p>	<p><b>Resilient Electric Grid</b> – System that will prevent cascading effects of power surge on electrical grids</p> <p><b>Levee Strengthening and Rapid Repair</b> - rapidly stop a breach in a levee</p> <p><b>Storm Surge and Hurricane Mitigation</b></p>

## High Impact Technology Solutions (HITS)

	<p><b>Real Time Bio Detection and Identify</b></p> <p><b>Cell-All -</b> Ubiquitous Chem/Bio/agent detector</p>	<p><b>First Net -</b> First Responder Reliable Relay Link</p> <p><b>Phone Home –</b> Inter-operative and inexpensive hand-held radios</p>	<p><b>Tunnel Detect –</b> Ability to detect, identify, and confirm illegal and clandestine underground border structures and activities</p>	<p><b>Document Validator</b> –High proficiency scanner that can identify fraudulent docs Leverage USSS system</p> <p><b>Biometric Detector</b> – High proficiency small biometric scanner</p>	<p><b>Wide Area Surveillance/ Change Detection for Critical Infrastructure</b></p> <p><b>Resilient Tunnel–</b> Tunnel Protection/Blast Mitigation</p>
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# Homeland Innovative Prototypical Solutions

## Counter-MANPADS/Persistent Surveillance

### Project Chloe

#### Counter-MANPADS Functions

1. MWS Detect & Declare
2. Slew & Hand-off
3. Track
4. Jam

65K Feet

Border & Critical Infrastructure Surveillance

Engagement Time:  
3-10 Seconds

Maritime Surveillance & Interdiction



**MANPADS**

#### Unmanned Aircraft Systems (UASs)

- High-Altitude Stand-Off Counter-MANPADS
- High Altitude – Wide-Area Coverage
- Long Endurance – Persistent Surveillance
- Large Payload – Multi-Sensor

#### Operational Characteristics

- Real-time sensor fusion/dissemination
- Multi-user / border surveillance requirements
- Commercial Aircraft MANPADS protection
- Automatic target detection/recognition
- Persistence (24/7, all-weather coverage)



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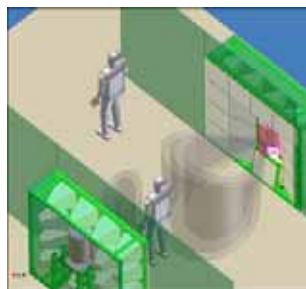
# High Innovative Prototype Solutions

## Improvised Explosive Devices Defeat



Masonry Walls

Explosive Resistant Coating



- Puffers for explosives trace material detection on people, bags/parcels, and vehicles
- Walk-through/whole-body imaging (e.g., backscatter)
- Advanced Protection Explosive (APE): cancellation methods for explosive shock waves
- Drive-through imaging technology (x-ray, neutron of materials only)



Active Armor

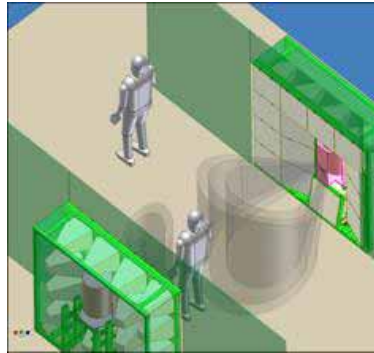


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Predict, Detect, Defeat and Destroy  
IED/VBIED at range (100 yards) to change the  
calculus of the bomber versus the defender

# Homeland Innovative Prototype Solutions

## Technologies for Suicide Bomber Defeat & Blast Mitigation



Suicide Bomber & Device Detection



Explosive Device Deactivation



Blast Mitigation



Reactive & Shaping Walls

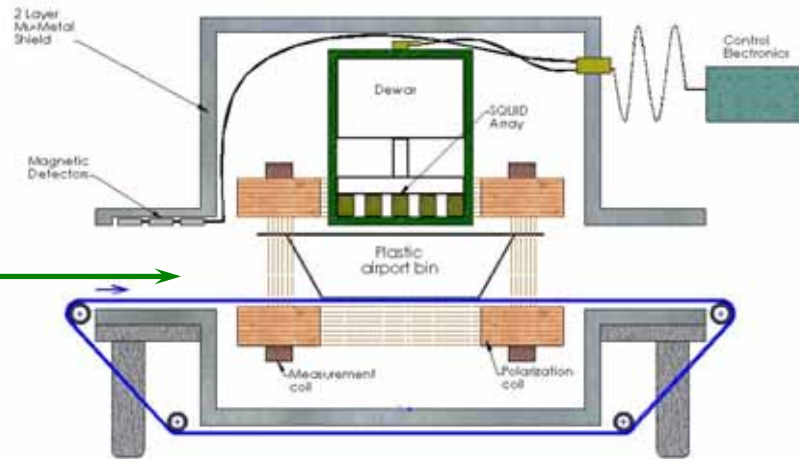


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# Homeland Innovative Prototypical Solutions

## SENSIT

Liquid & Solid Explosive Detection at  
Ultra-Low Field *without radiation*



## Magnetic Resonance Technology

- Detect Liquid & Solid Explosives
- Detect Explosive Components
- Simple “Green” / “Yellow” / “Red” alerts
- Non-contact
- Extremely sensitive
- Materials remain inside baggage
- Applicable at any security portal

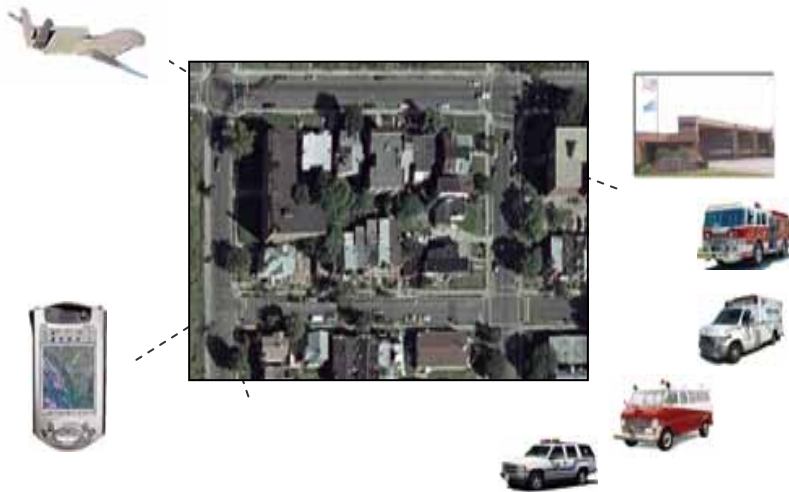


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# Homeland Innovative Prototypical Solutions

## Scalable Common Operating Picture Experiment JCTD



# Homeland Innovative Prototypical Solutions

## Scalable Composite Vessel Prototype



Gel-coated Composite eliminates manpower, cost, and environmental impact of constant hull preservation

Stern Launch and Recovery of 7 meter RHIB

Monolithic composite hull provides robust structure without seams or joints



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# Homeland Innovative Prototypical Solutions

## SAFECON

### Quickly Detect and Identify Dangerous Cargo

Integrated Sensor Suite: explosives, chemical agents, biological agents, human cargo, contraband

Scan for WMD, contraband, and human cargo during normal crane transport operations



- Improved Non-Intrusive Inspection (NII) capability
- Improved Sensors for explosives, Chem and Bio agents



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Security**



# Homeland Innovative Prototype Solutions

## Future Attribute Screening Technology Mobile Module (FAST M2)



### Systems

- Queue management
- Behavioral profiling
- Rapid risk assessment
- Screening methodologies

### Operational Characteristics

- Discover screening methods for intent
- Privacy protection for all participants
- Simple to operate and use

### Functions

- Identity verification
- Attribute measurement
- Risk determination
- Behavior focused screening



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Security**

# Homeland Innovative Prototypical Solutions

## Levee Strengthening and Rapid Repair

**Pre-emptive mapping  
of weak levees**

**Pre-Flood Deployment of Protective  
And Rapid Repair Supplies to  
Problem Locations**

**Drop-in structures  
lofted by aircraft**



**Float-in structure guided  
by cables**

**Explosively Emplaced  
Support Structures**

**Roll-out protective  
coverings such as  
articulated concrete mats**

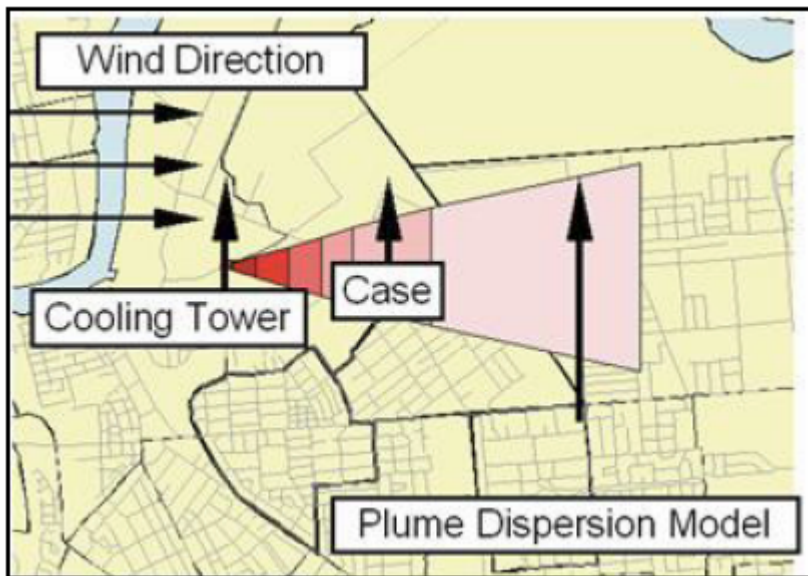


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# High Impact Technology Solutions

## Real Time Bio Detect

Systems to detect biological agents in less than 60 seconds, and then provide RF information transfer to various centers for decision making and corrective action.



VS

Detection via cell culture



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# High Impact Technology Solutions

## First Net



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# High Impact Technology Solutions

## Tunnel Detection



- Air circulation
- Electricity
- Concrete infrastructures



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# High Impact Technology Solutions

## Document Validator

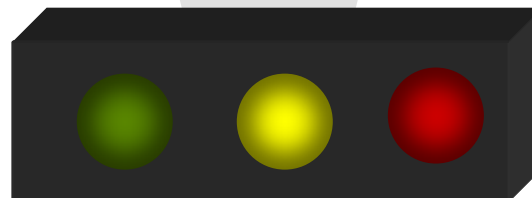


### Systems

- Immigration Control
- Queue Management
- Identity databases

### Functions

- Document Validation
- Identity verification
- Global identity awareness



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# High Impact Technology Solutions

## Biometric Detector



### Functions

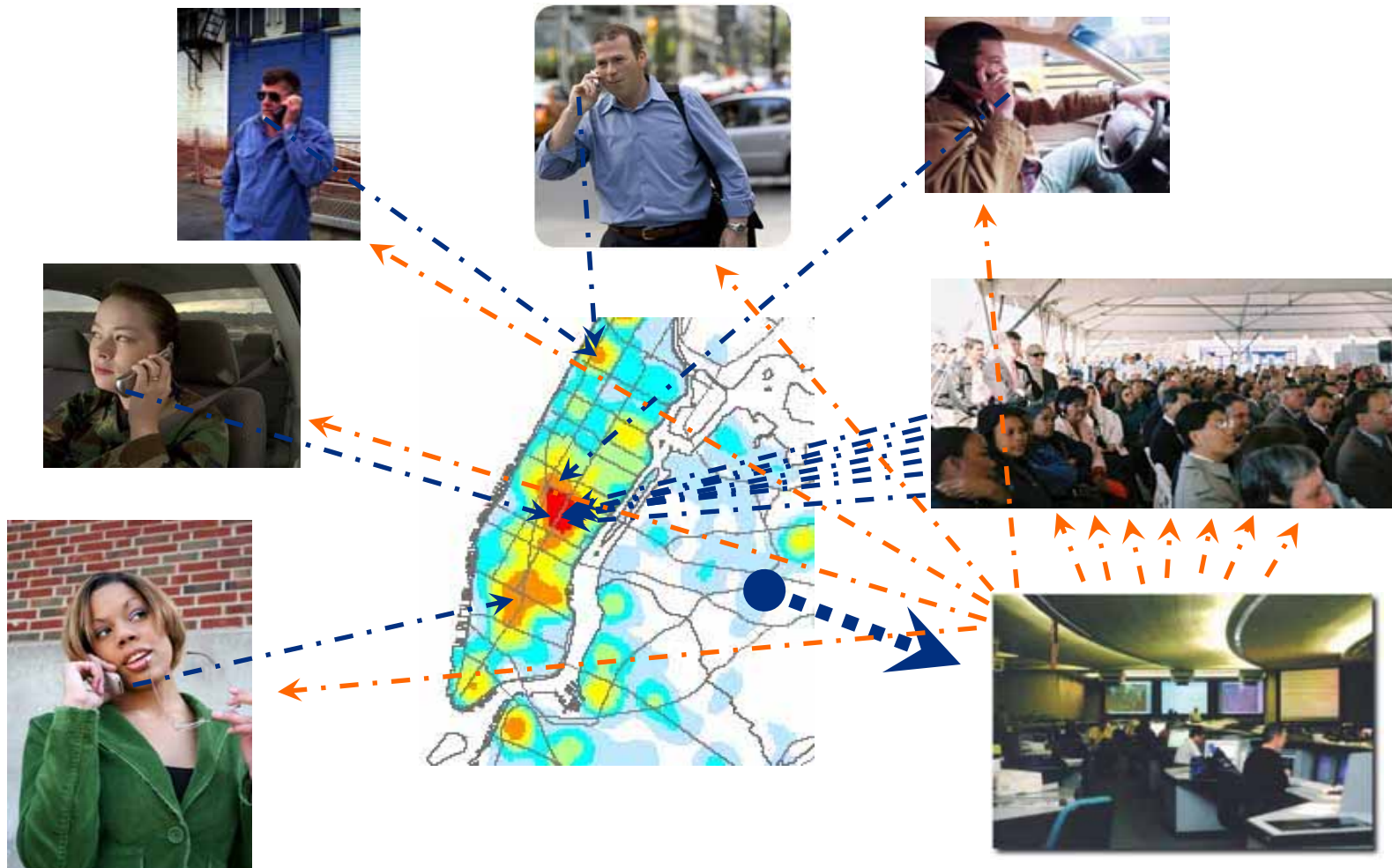
- Identity verification
- Denies right of passage to those on watch lists
- Mobility allows for use in remote locations
- Improved movement of legitimate individuals through checkpoints



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# High Impact Technology Solutions

## Cell-All Ubiquitous Chem/Bio Detect



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# High Impact Technology Solutions

## Critical Infrastructure Change Detection

Explore Methods to  
Monitor Critical  
Infrastructure



Large and Remote  
Locations



Densely Populated  
Urban Environments



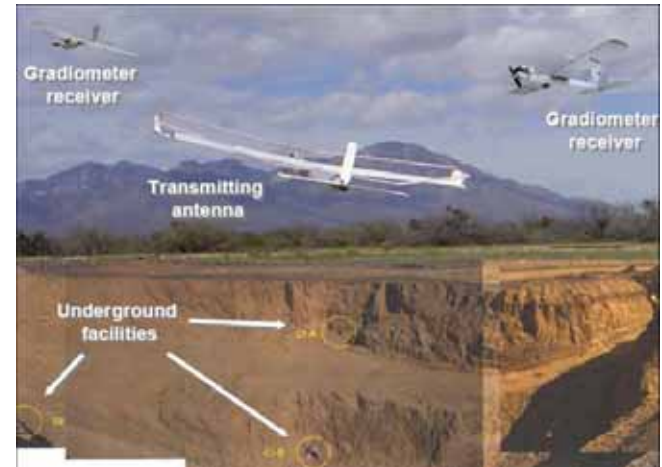
Homeland  
Security



# Innovation/HSARPA BAAs

Broad Agency Announcements Released  
February 1:

- Tunnel Detection Technologies - develop and demonstrate a capability for rapidly detecting tunnels
- SAFE Container (SAFECON) – develop the capability to detect and identify WMD, explosives and contraband cargo and to detect humans in shipping containers
- Future Attribute Screening Technology (FAST) Demonstration Laboratory – provide efficient, rapid and accurate security screening of people and their credentials and belongings



Visit [www.FedBizOpps.gov](http://www.FedBizOpps.gov) or  
[www.hsarpabaa.com](http://www.hsarpabaa.com) for more information

- SBIR - Small Business I
- First NET - First Respon
- Document Validator
- Biometric Detector
- SCOPE: Scalable Comr

- [illegible]



# DoD-DHS Technology Transfer

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- Identify and transfer technology from DoD to homeland security applications for emergency responders
- Create a coordinated, sustainable, iterative and inclusive process for tech transfer
- Leverage innovation and investments
- Promote agency and first responder awareness of process



Homeland  
Security



# S&T Directorate's A/P Liaison

---

- Gary Jensen, Director, Asia-Pacific Liaison
- DHS Science & Technology Directorate
- 26 years experience in the Pacific Region
- Established first Mid-Pacific Office for Naval Research
- Coordinated Pacific Region International Field Offices for ONR
- Contact:
  - [gary.jensen@dhs.gov](mailto:gary.jensen@dhs.gov)
  - Phone: 808-474-1240



Homeland  
Security

# S&T Activities in PACASIA

- **Government to Government Agreements**

- An existing umbrella S&T agreement with the Government of Australia,
- An umbrella S&T agreement in progress with the Government of Singapore
- Ongoing collaborations with both industry and government in Japan to test cargo container tracking devices under real-world operational conditions.
- Plans to expand this cargo security initiative to Singapore as soon as our S&T agreement is in place.



Homeland  
Security

# S&T Focus in PACASIA

- **Needs of our customers**
- - Chemical and biological countermeasures and forensics;
  - Behavioral and physiological tools for people screening; and
  - Cargo tracking and inspection systems.
- **Capitalize on the environment and challenges for innovative and leap-ahead capabilities in support of DHS missions and to save American lives. These include**
  - Investigating emergency responder tools used by the Japanese government in response to earthquakes
  - Developing satellite-based tsunami forecasting capabilities with our partners in Naval Research
  - Developing hurricane intensity prediction approaches in partnership with the Office of Naval Research and the Mexican Navy
  - Maritime domain awareness and port security tools in partnership with Naval Research, TSWG, and allies such as Singapore.



Homeland  
Security



# It's ALL about the *'Human Element'!*



**Dow's  
“Human Element” Ad**



**Homeland  
Security**



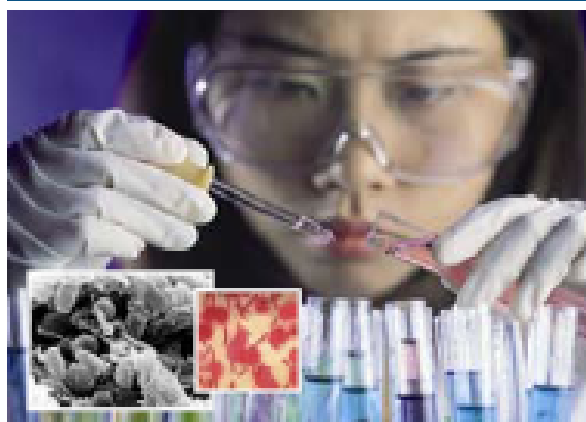
Homeland  
Security

**FROM SCIENCE...SECURITY**

**Explosives**



**Chemical/Biological**



**Command, Control, &  
Interoperability**



**Borders/Maritime**



**Human Factors**



**Infrastructure/Geophysical**



**FROM TECHNOLOGY...TRUST**

Back-Up



# S&T Points of Contact

Division	Email
Jim Tuttle	S&T-Explosives@dhs.gov
John Vitko	S&T-ChemBio@dhs.gov
David Boyd	S&T-C2I@dhs.gov
Dave Newton	S&T-BordersMaritime@dhs.gov
Sharla Rausch	S&T-HumanFactors@dhs.gov
Chris Doyle	S&T-InfrastructureGeophysical@dhs.gov
Bob Hooks	S&T-Transition@dhs.gov
Starnes Walker	S&T-Research@dhs.gov
Roger McGinnis	S&T-Innovation@dhs.gov
Lil Ramirez	S&T-InternationalPrograms@dhs.gov

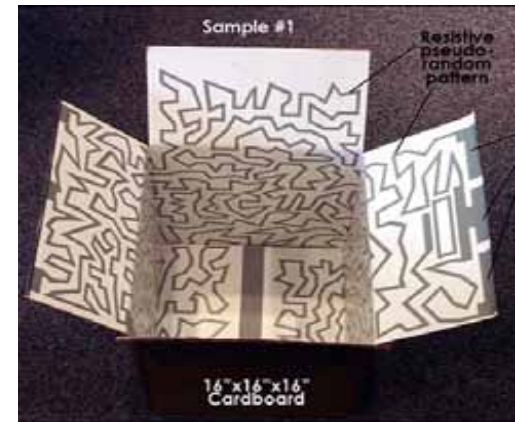
# Border Security: Representative Technology Needs

- Improved ballistic protection via personal protective equipment  
(*Borders/Maritime Division Lead*)
- Improve detection, tracking, and identification of all threats along the terrestrial and maritime border  
(*Borders/Maritime Division Lead*)
- Ability to access ICE databases in which voice information is entered; provide analytical, reporting, and automated case deconfliction; classify, identify voice samples (*C2I Division*)
- Non-lethal compliance measures for vehicles, vessels, or aircraft allowing for safe interdiction by law enforcement personnel (*Borders/Maritime Division Lead*)
- Non-destructive tools that allow for the inspection of hidden or closed compartments to find contraband or security threats (*Borders/Maritime Division Lead*)
- Improved analysis and decision-making tools that will ensure the development/implementation of border security initiatives (*Borders/Maritime Division Lead*)
- Ability to non-intrusively determine the intent of subjects during questioning  
(*Human Factors Division*)
- Ability for law enforcement personnel to quickly identify the origin of gunfire and classify the type of weapon fired (*Borders/Maritime Division Lead*)
- Ability for law enforcement officers to assure compliance of lawful orders using non-lethal means  
(*Borders/Maritime Division Lead*)



# Cargo Security: Representative Technology Needs

- Enhanced screening and examination by non-intrusive inspection  
(*Borders/Maritime Division*)
- Increased information fusion, anomaly detection, Automatic Target Recognition capability (*Borders/Maritime Division*)
- Detect and identify WMD materials and contraband (*Borders/Maritime Division*)
- Capability to screen 100% of air cargo  
(*Borders/Maritime Division*)
- Test the feasibility of seal security; Detection of intrusion  
(*Borders/Maritime Division*)
- Track domestic high-threat cargo (*Borders/Maritime Division*)
- Harden air cargo conveyances and containers (*Borders/Maritime Division*)
- Positive ID of cargo & detection of intrusion or unauthorized access  
(*Borders/Maritime Division*)



Homeland  
Security



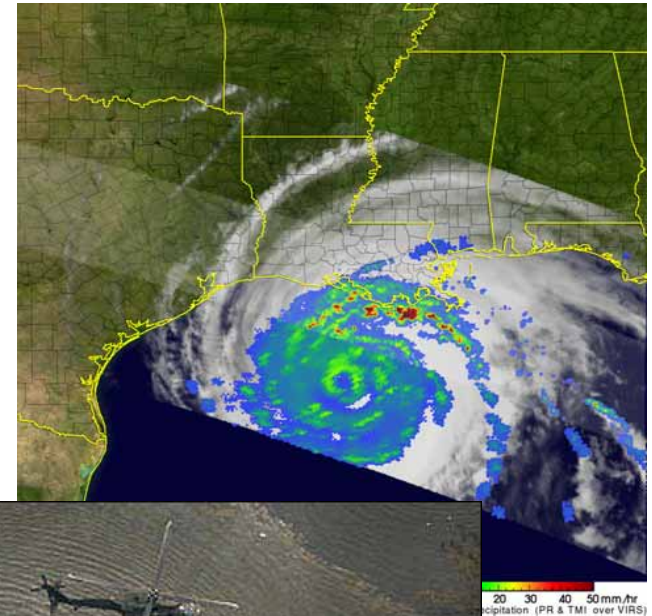
# Explosives Prevention: Representative Technology Needs

- Standoff detection on persons (portable solutions) (*Explosives Division*)
- System solution for detection in baggage (checked & carried) (*Explosives Division*)
- Capability to detect VBIED / large threat mass (container, trailer, ship, vessel, car, rail) (*Explosives Division*)
- Capability to detect homemade or novel explosives (*Explosives Division*)
- Capability to assess, render safe, and neutralize explosive threats (*Explosives Division*)
- Optimize canine explosive detection capability (*Explosives Division*)



# Incident Management: Representative Technology Needs

- Integrated Modeling, Mapping and Simulation capability (*IP/Geophysical Division*)
- Personnel Monitoring (Emergency Responder Locator System) capability (*IP/Geophysical Division*)
- Personnel Monitoring (Physiological Monitoring of Firefighters) capability (*IP/Geophysical Division*)
- Incident Management Enterprise System (*IP/Geophysical Division*)
- Logistics management tool (*IP/Geophysical Division*)



Homeland  
Security

# Interoperability: Representative Technology Needs



- Development and evaluation of Internet Protocol (IP) enabled backbones (*C2I Division*)
- Test and evaluation of emergent wireless broadband data systems (*C2I Division*)
- Acceleration of development and testing of P25 IP-based interfaces (*C2I Division*)
- Identification and development of message interface standards (*C2I Division*)
- Transition of Land Mobile Radios communication architectures to cellular based architectures (*C2I Division*)
- Evaluation of access technologies (*C2I Division*)
- Development of the complementary test procedures (*C2I Division*)





# Maritime Security: Representative Technology Needs

- Wide-area surveillance from the coast to beyond the horizon; port and inland waterways region - detect, ID, and track  
(*Borders/Maritime Division Lead*)
- Data fusion and automated tools for command center operations (*Borders/Maritime Division Lead*)
- Vessel compliance through non-lethal compliance methods (*Borders/Maritime Division Lead*)
- Enhanced capability to continuously track contraband on ships or containers  
(*Borders/Maritime Division*)
- Improved ballistic personal protective equipment for officer safety  
(*Borders/Maritime Division Lead*)
- Improved WMD detection equipment for officer safety; improved screening capability for WMD for maritime security checkpoints (*Borders/Maritime Division Lead*)



# People Screening: Representative Technology Needs

- Systematic collection and analysis of information related to understanding terrorist group intent to engage in violence  
(*Human Factors Division*)
- Non-invasive monitoring: Identifying and tracking unknown or potential threats from individuals at key checkpoints. Real-time detection of deception or hostile intent through integrated system of human and machine methods (*Human Factors Division*)
- Capability in real-time for positive verification of individual's identity utilizing multiple biometrics (*Human Factors Division*)
- Capability for secure, non-contact electronic credentials; contactless readers or remote interrogation technologies for electronic credentials (*Human Factors Division*)
- Mobile biometrics screening capabilities, to include hand-held, wireless, and secure devices (*Human Factors Division*)
- High-speed, high-fidelity ten-print capture capability  
(*Human Factors Division*)



2007 HOMELAND SECURITY  
*S&T Stakeholders*  
CONFERENCE



*A World in Change*

**May 21-24, 2007**

**Ronald Reagan Building**  
Washington, D.C.

Presented by:



2007 S&T  
Stakeholders  
Conference  
Washington, DC

For more information visit:  
<http://www.ndia.org/meetings/7680>

*Coming Up...*  
*DHS S&T Conference*  
*London - Dec. 4, 2007*  
*Details to follow*



# Security challenges from the perspective of a small city state

PACOM Operational S&T Conference 2007

3 Apr 2007

Richard Lim, Rear Admiral (Retired) RSN

Chief Executive

Defence Science and Technology Agency

**Singapore has enjoyed 42 years of peace and economic progress as an independent nation**



**Key contributors to success:**

- A diversified and open economy plugged into the global marketplace
- A strong commitment to defence and security (6% GDP)
- Social and religious harmony

**But the  
fundamentals  
behind its security  
challenges remain  
basically  
unchanged since  
independence in  
1965**





- 
- A satellite map of Singapore, showing its island geography, surrounding waters, and the surrounding landmasses of Sumatra and Java. The island is characterized by its green landscape and urban areas. The text is overlaid on the central part of the island.
- **No strategic depth**
  - **Small population**
  - **Limited space for military training**

## **Singapore**

- Area = 707 sq km (22% reclaimed)
- 42 km length; 23 km breadth
- Population = 4.3m (3.2m citizens)

## **New York City**

- Area = 785 sq km
- Population = 8 million



A satellite image of a coastal region, likely a large bay or harbor. The water is dark blue, and the surrounding land is a mix of green vegetation and urban development. A large, winding waterway or river cuts through the land. The text "No strategic depth" is overlaid in yellow.

**No strategic depth**

- **Persistent stand-off long range surveillance & early warning**
- **Robust air and island defence capabilities**
- **Protection of critical assets against surprise attack**
- **High operational readiness to respond quickly to threats**
- **Total Defence: civil, psychological, economic, social and military**



Small population

# Conscript Armed Forces

Two years of national service

300.000 when mobilised





Limited space for military training

# Overseas Training



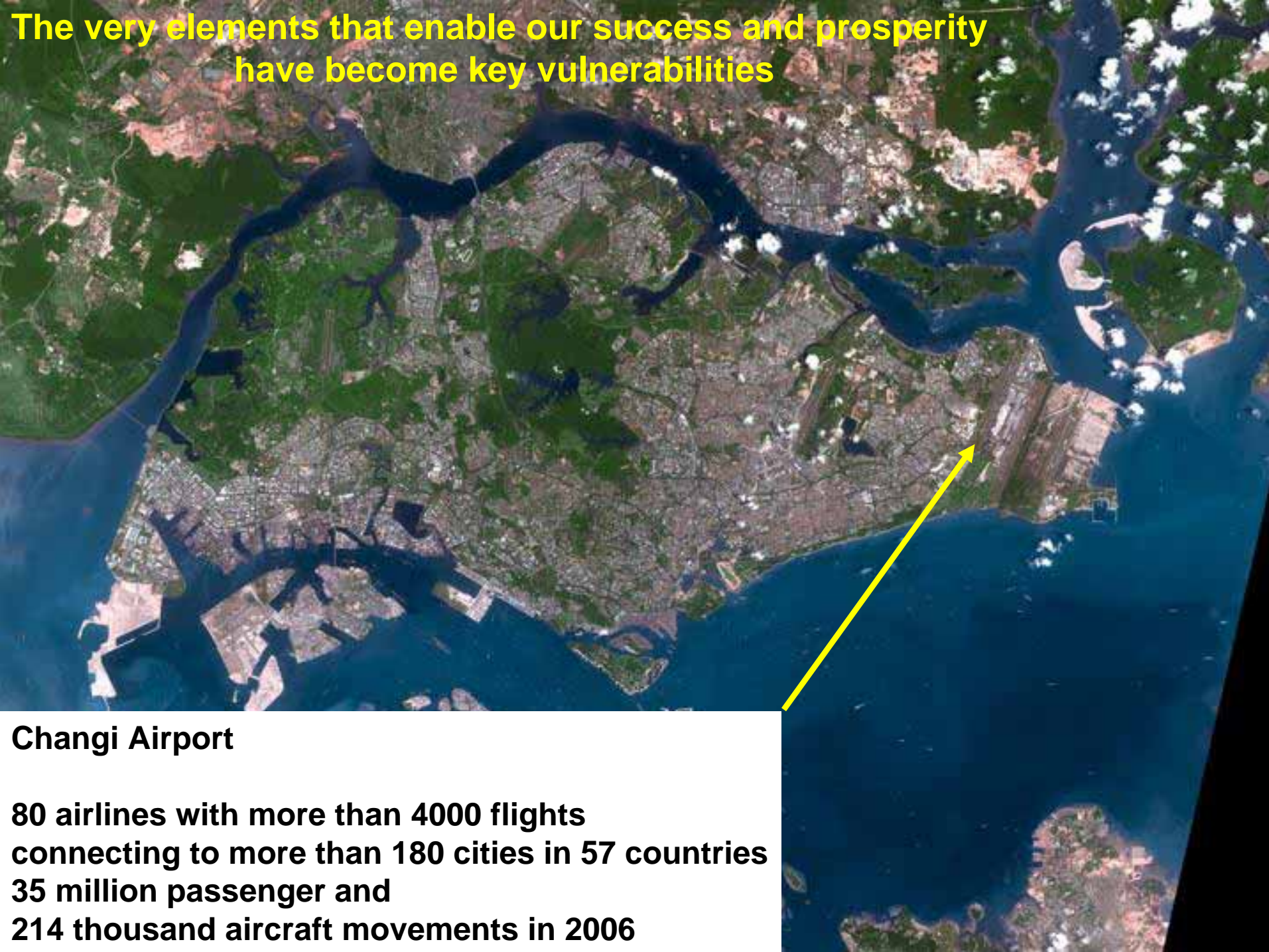




**Our security challenges have become more complex**







**The very elements that enable our success and prosperity  
have become key vulnerabilities**

## **Changi Airport**

**80 airlines with more than 4000 flights  
connecting to more than 180 cities in 57 countries  
35 million passenger and  
214 thousand aircraft movements in 2006**



**The very elements that enable our success and prosperity  
have become key vulnerabilities**

A satellite image of Hong Kong, showing the dense urban landscape and the surrounding sea. A yellow arrow points from a text box in the lower right to a narrow causeway connecting two parts of the island.

**60 thousand vehicles pass  
through the causeway each  
day**

**8.94 million tourists arrivals**

The very elements that enable our success and prosperity  
have become key vulnerabilities



## Singapore Port

200 shipping lines with links to 600  
ports in 120 countries

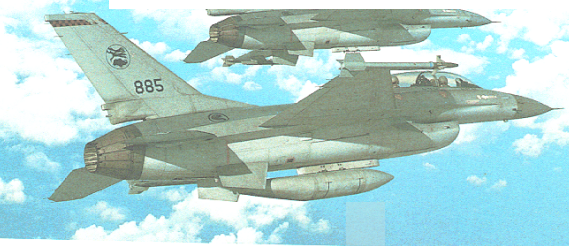
140,000 vessels call annually

24 million containers (TEU) or 6% of  
global container throughput handled  
in 2006



# SINGAPORE ARMED FORCES

While architected for deterrence and the defence of Singapore, the SAF has found itself deployed for various operations other than war





# Peace Support Operations

- Singapore is committed to the UN and its mission in maintaining international peace and security
- 1500 SAF peacekeepers sent to various missions since 1989
- Operating out of traditional areas
  - East Timor
  - Middle East: Iraq and Afghanistan

# Participation in UN PSO

UN Mission	Date	Role(s) in Mission
UNTAG, Namibia	Oct to Nov 89	Election Supervisors
Ops Nightingale	Jan to Mar 91	Medical Team
UNIKOM, Iraq-Kuwait	Apr 91 to Mar 03	Military Observers
UNAVEM II, Angola	Jul 91 to Dec 92	Military Observers
UNTAC, Cambodia	May to Jun 93	Helicopter Detachment, Election Supervisors
UNOMSA, South Africa	Apr to May 94	Election Supervisors
UN HQ – DPKO, New York	Nov 95 to Present	Appointments in DPKO
UNSCOM (UN Special Commission in Iraq)	Jun 96	Member of UN Special Commission Inspection Team
MINUGUA, Guatemala	Feb to May 97	Medical Team
UNSMA, Afghanistan	May 97 to May 98	UN Military Adviser
<b>International Force for East Timor (INTERFET)</b>	<b>20 Sept 99 to Feb 00</b>	<b>Medical Team, Military Liaison Teams</b>
<b>UN Transitional Administration in East Timor (UNTAET)</b>	<b>Feb 00 to May 02</b>	<b>UNTAET HQ Staff, Medical teams and Peacekeeping troops</b>
UN Mission in Ethiopia and Eritrea (UNMEE)	May 00 to Jul 03	Military Observers
<b>UN Mission of Support in East Timor (UNMISET)</b>	<b>May 02 to 22 Oct 03</b>	<b>Force Commander, UNMISET HQ staff, Peacekeeping troops and Helicopter detachment</b> <b>3 SAF PKF HQ Staff remain till May 04</b>

# Timor Leste

- **INTERFET**

- 4- men Liaison Team
- 3 x LST for 2 months each
- 1 x C130 for two weeks
- 26- personnel Medical Team
- 40 police personnel
- Cumulative total of 373 personnel involved

- **UNTAET**

- 4 x PKO HQ staff,
- 3 x 61-men Platoon Task Force in Western Sector
- 9 x 21-men Medical Team
- 40 x Police Personnel

- **UNMISET**

- May 02 onwards - Over 250 personnel
- Force Comdr UNMISET- PKF
- Staff Planners at PKF HQ
- Helicopter Detachment - 4 x UHHH
  - Infantry Company





# OEF / OIF



**LST**



**KC-135**



**C-130**

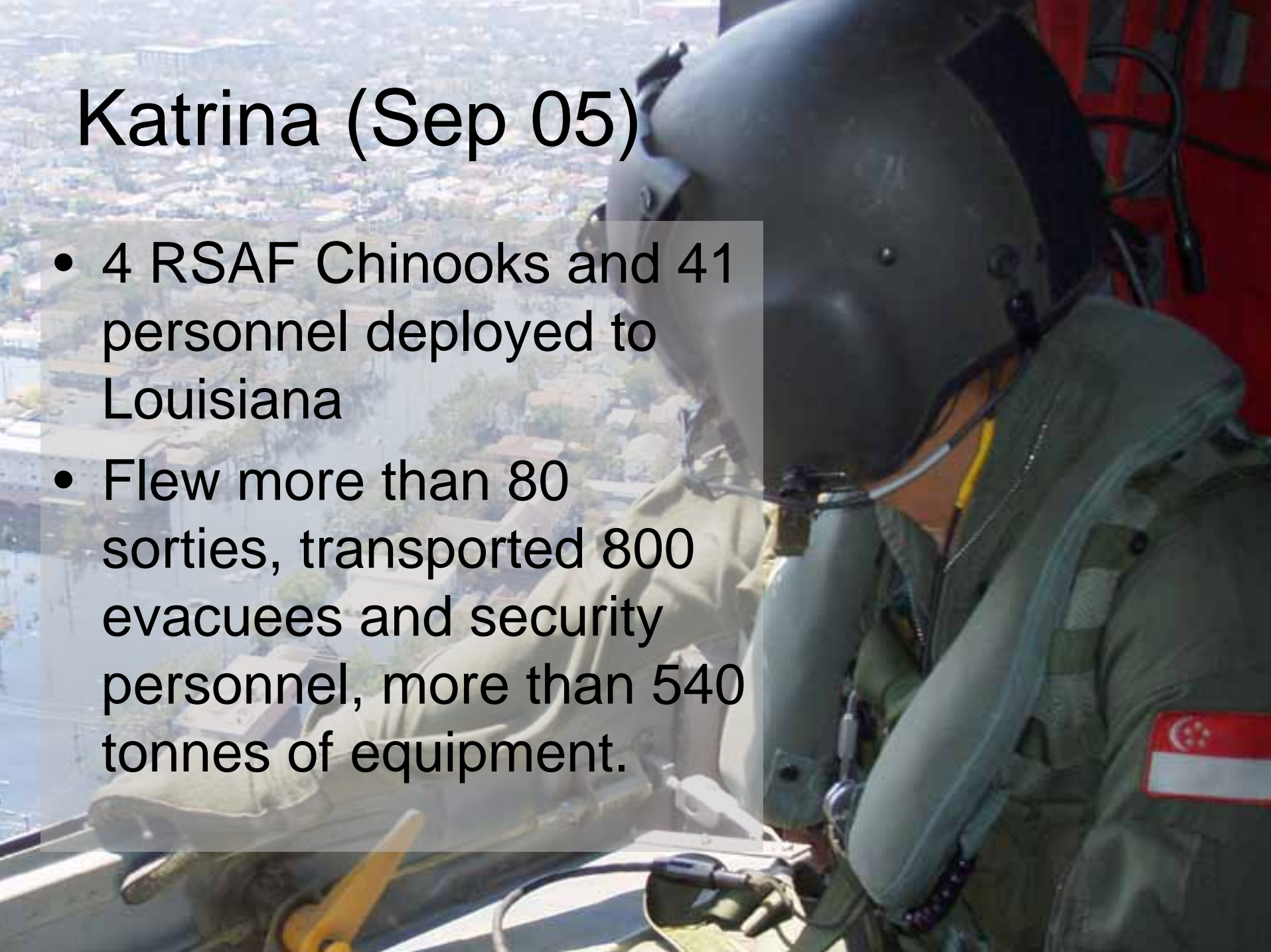
- **Landing Ship Tank (LST)**
  - Monitor vessels to and from ports in Iraq
  - Compliant boarding operations
  - Health and comfort support to detained vessels
  - Platform support for helicopter operations
  - Guardship duties
- **KC-135**
  - Air-to-air refuelling
- **C130**
  - Strategic lift for personnel and cargo
  - Aeromedevac

# Indian Ocean Tsunami



# Katrina (Sep 05)

- 4 RSAF Chinooks and 41 personnel deployed to Louisiana
- Flew more than 80 sorties, transported 800 evacuees and security personnel, more than 540 tonnes of equipment.





# Yogyakarta Earthquake

(27 May 06)

- Medical detachment deployed
  - TNI Field Hospital in Plered, Bantul
  - Bantul District Hospital
- US\$250,000 worth of humanitarian supplies (approx 24 tons)
  - 750 tentages
  - 4,200 blankets
  - 400 cot beds
  - 1,300 sleeping bags
  - Medical supplies



# Provincial Reconstructive Team

Bamiyan, Afghanistan

- Part of New Zealand Reconstruction Team
- Set up of dental clinic & training of locals in dentistry and basic healthcare
- Bridge construction and repair work

# Support for Homeland Security



**Maritime C3 and Coastal Surveillance**



**Police/SCDF C3**



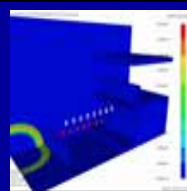
**Consequence Assessment**



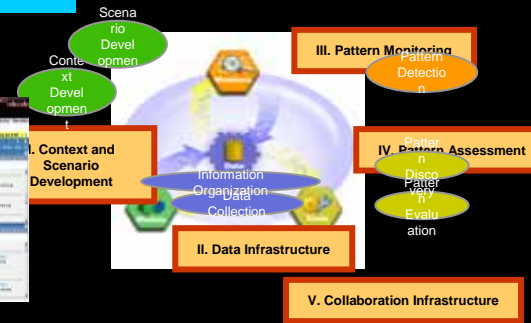
**Explosive Testing**



**Crisis Information Management**



**Infrastructure Hardening**



**Risk Assessment Horizon Scanning**



An aerial, black-and-white photograph of a coastal city, likely San Francisco, showing the city's layout, the bay, and the surrounding hills. The city is densely packed with buildings and infrastructure, with the bay providing a natural harbor. The surrounding land is hilly and less developed.

Maritime Security .....

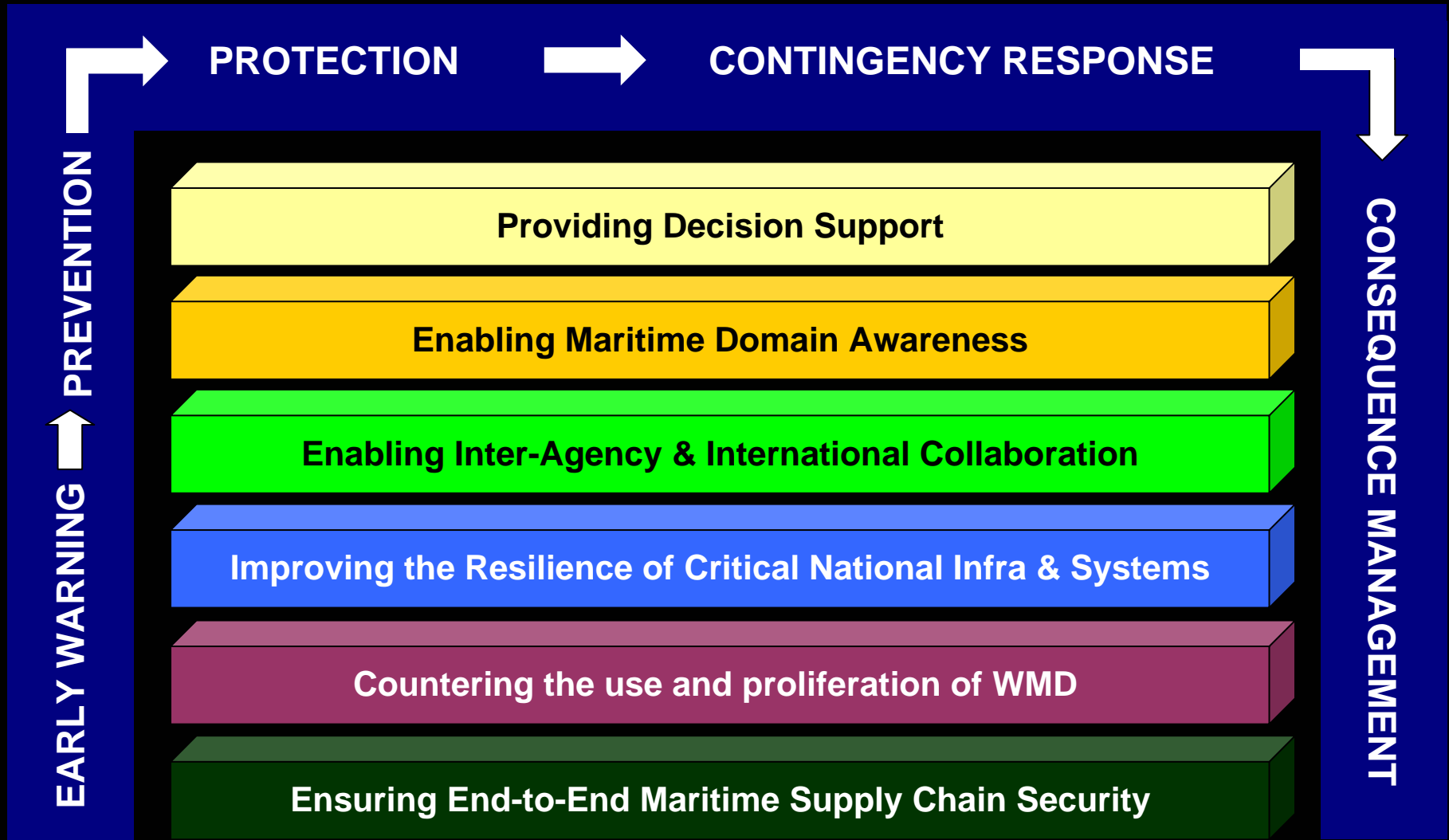
....is a complex multi-dimensional challenge





Half of the world's oil and almost one-third of the world's trade

# Technology support in .....



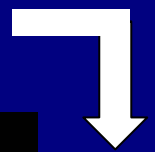


EARLY WARNING → PREVENTION

PROTECTION



CONTINGENCY RESPONSE



CONSEQUENCE MANAGEMENT

Providing Decision Support



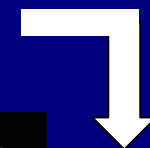
- Vulnerability and risk assessments of critical infrastructure

**EARLY WARNING** → **PREVENTION**

**PROTECTION**



**CONTINGENCY RESPONSE**



**CONSEQUENCE MANAGEMENT**

**Enabling Maritime Domain Awareness**



Video mosaic

EARLY WARNING → PREVENTION

PROTECTION



CONTINGENCY RESPONSE

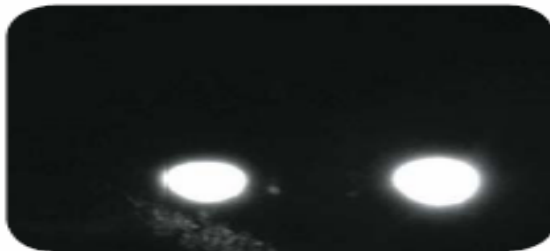
CONSEQUENCE MANAGEMENT

### Enabling Maritime Domain Awareness

Passive mode

Distance 750 m

Laser on



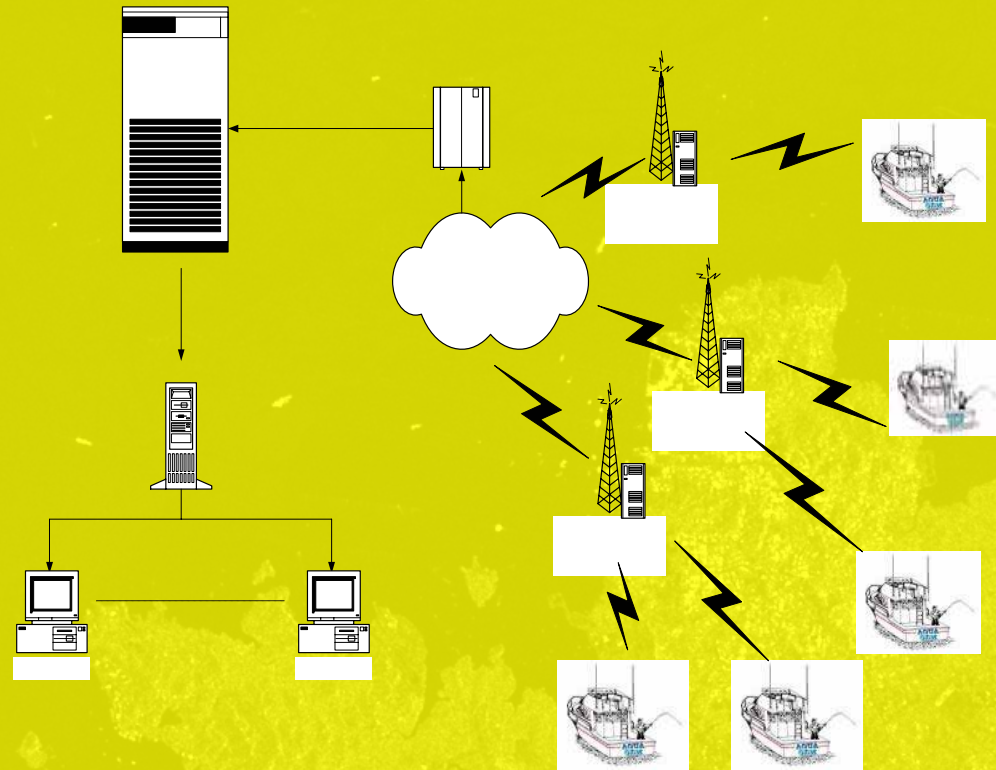
Distance 1.4 km



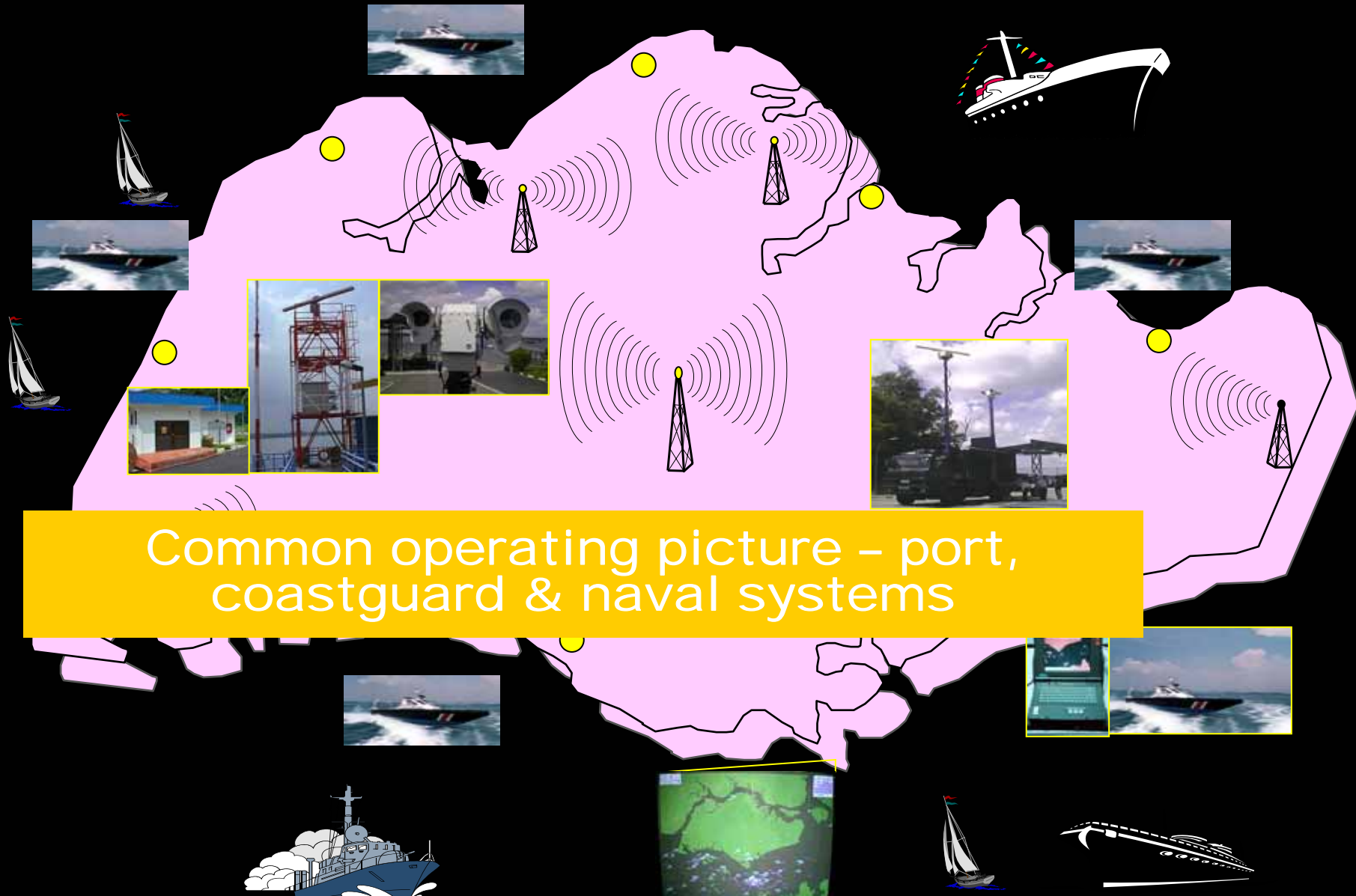
Active imaging



# Harbour Craft Transponder System



## Enabling Inter-Agency & International Collaboration





A satellite map of Singapore, showing the island's urban landscape, green spaces, and surrounding waters. A red star is placed on the eastern coast, near the airport, with an arrow pointing to it from the text below.

## Enabling Inter-Agency & International Collaboration

- Promote interoperability with international forces

CHANGI C2 CENTRE



## Enhancing Resilience of Critical National Infra & Systems



## Enhancing Resilience of Critical National Infra & Systems



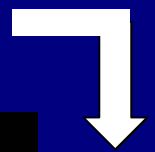
Explosive effects testing

EARLY WARNING → PREVENTION

PROTECTION

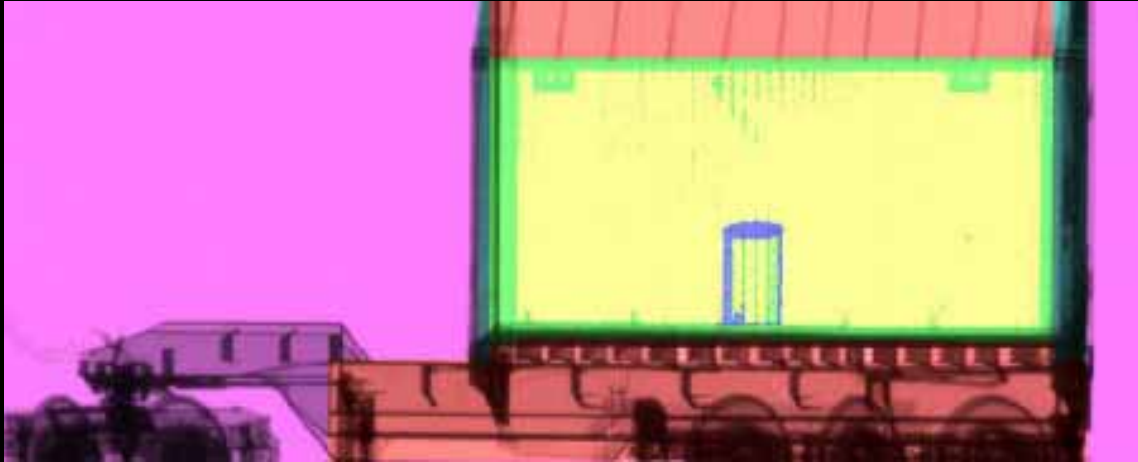


CONTINGENCY RESPONSE



CONSEQUENCE MANAGEMENT

Countering the use and proliferation of WMD



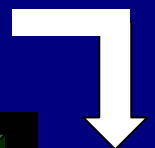


EARLY WARNING → PREVENTION

PROTECTION

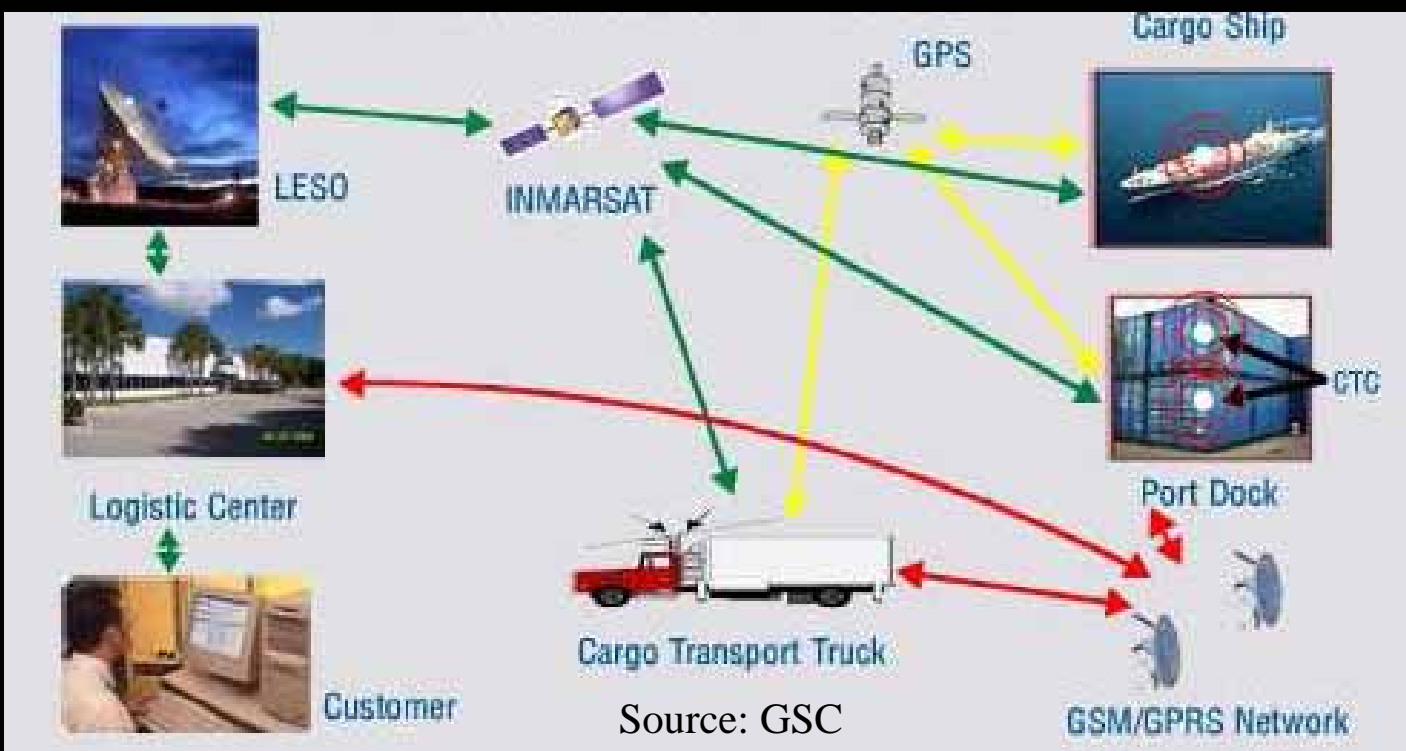


CONTINGENCY RESPONSE

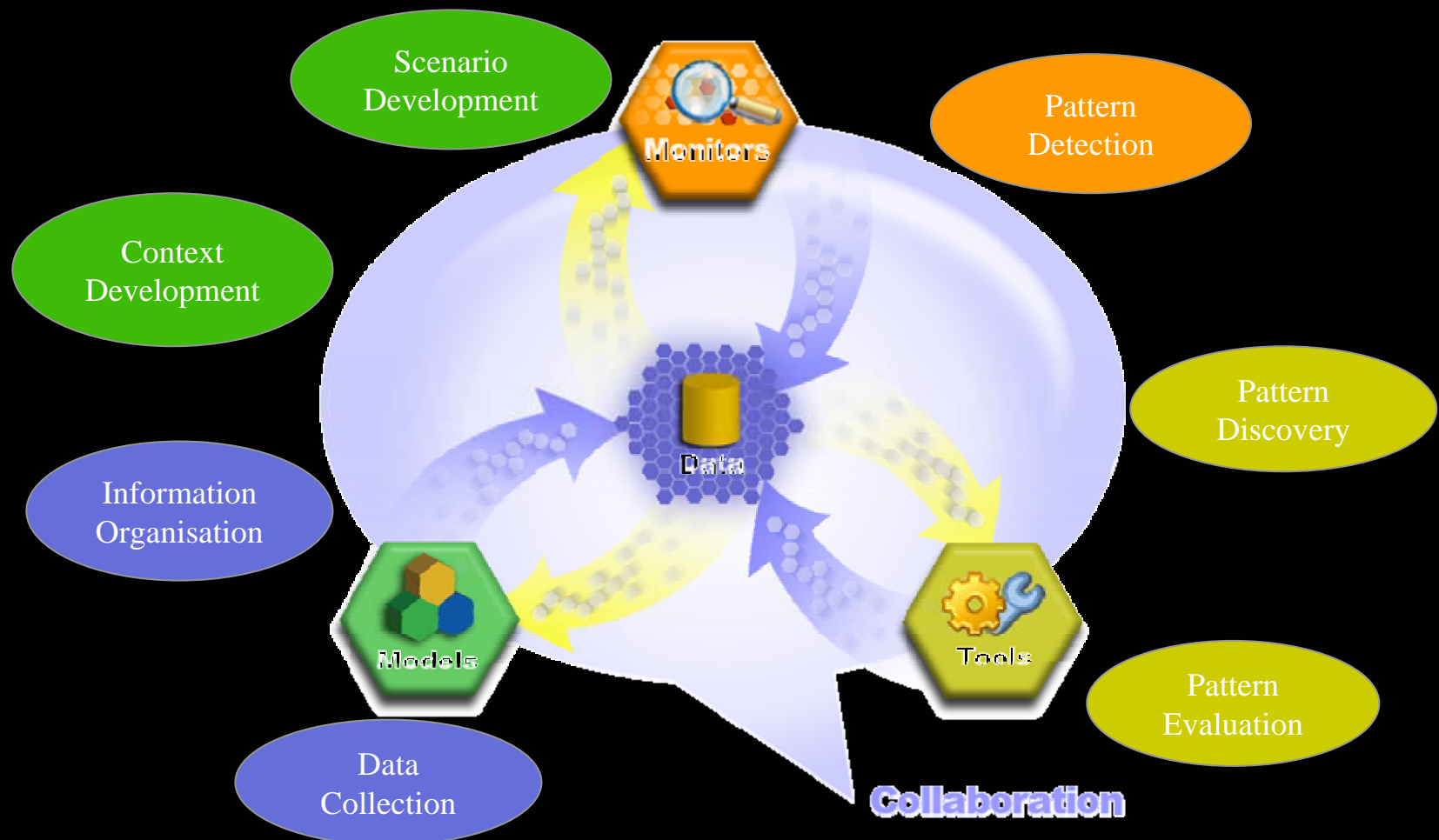


CONSEQUENCE MANAGEMENT

## Ensuring End-to-End Maritime Supply Chain Security



# Risk Assessment & Horizon Scanning (RAHS)



# **International collaboration**





# FPDA (Five Power Defence Arrangements)



# INDO-SIN Co-ordinated Patrols (ISCP)



# Malacca Strait Patrols

- Malacca Strait Sea Patrols (MSSP)
- Eyes in the Sky (EiS)





# Exercise Deep Sabre 05



- Singapore-hosted, first PSI exercise in Southeast Asia.
- Distinct Features:
  - Table Top Exercise (TTX)
  - Maritime Interdiction Operations
  - Combined Co-ordination Centre
  - Port Search Phase
  - Exercise Debrief Session



# CMA JCTD with PACOM

Coastal Command

Scale: 36 nm

Search:

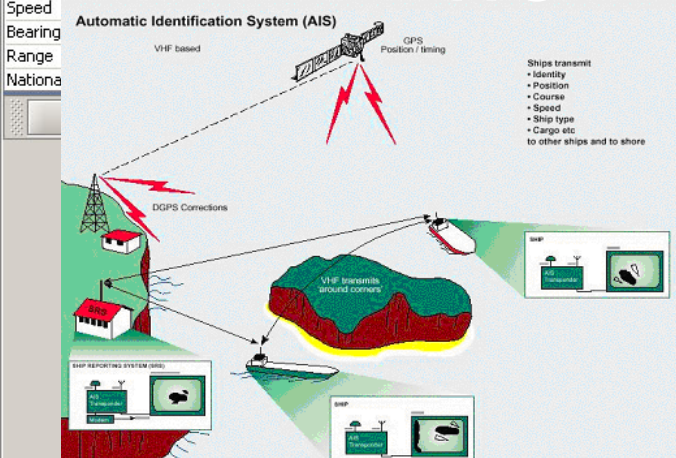
## Coastal Sensors



## Situation Awareness

## Lloyd's Register Database

## AIS



Lloyd's Register - Ship Overview and Index

Back

Forward

Details

U-View

ID Nos

Notes

F / M

History

Owners

T

REGIM

Print

Close

Help

Ship Overview & Index

Ship Name: ACQUAMARINA

Feedback

Owner Name(s):

U Field

Ship Overview

Type/Subtype: Chemical / Oil Products Tanker

Gross Tonnage: 8228

Type Grouping:

Class: AB IN CLS 2004 08

Shipbuilder: MORINI

RI: IN CLS

Flag: Italy

Port of Registry: Ancona

Status: In Service/Commission

DOB: 2003 12

Sister:

Location:

Nationality:

Acquired:

Shipmanager: Firbeta

Italy

Italy

2003

Fleet Manager: Firbeta

Italy

2003

Name	Shiptype	DOB	GT	Class	Class Stat.	Status
ABUSAMAH	Urea Carrier	1984 02	7,579 LR	IN CLS	In Service/Comm	
ACAMAR	Bulk Carrier	1977 03	34,963 CR	IN CLS	In Service/Comm	
ACAMAR	Trawler	1990 08	3,708 PR	IN CLS	In Service/Comm	
ACAMAR	Offshore Supply Ship	1983 01	386 AB	IN CLS	In Service/Comm	
ACAMAR B	Trawler	1986 06	129 NV	(DISC)	In Service/Comm	
ACQUAMARINA	Chemical / Oil Products Tanker	2003 12	8,228 AB	IN CLS	In Service/Comm	
ADAMANT	Fishing Support Vessel	1959 05	973 LR	(DISC)	In Service/Comm	
ADAMANT	Naval / Naval Auxiliary	1992 12	134 LR	IN CLS	In Service/Comm	
ADAMAS II	Yacht	1987 04	674 LR	IN CLS	In Service/Comm	
ADAMASTOS	Bulk Carrier	1986 01	10,765 NK	IN CLS	In Service/Comm	
ADHIGUNA MULIAMARGA	General Cargo Ship	1984 04	3,509 KI	IN CLS	In Service/Comm	

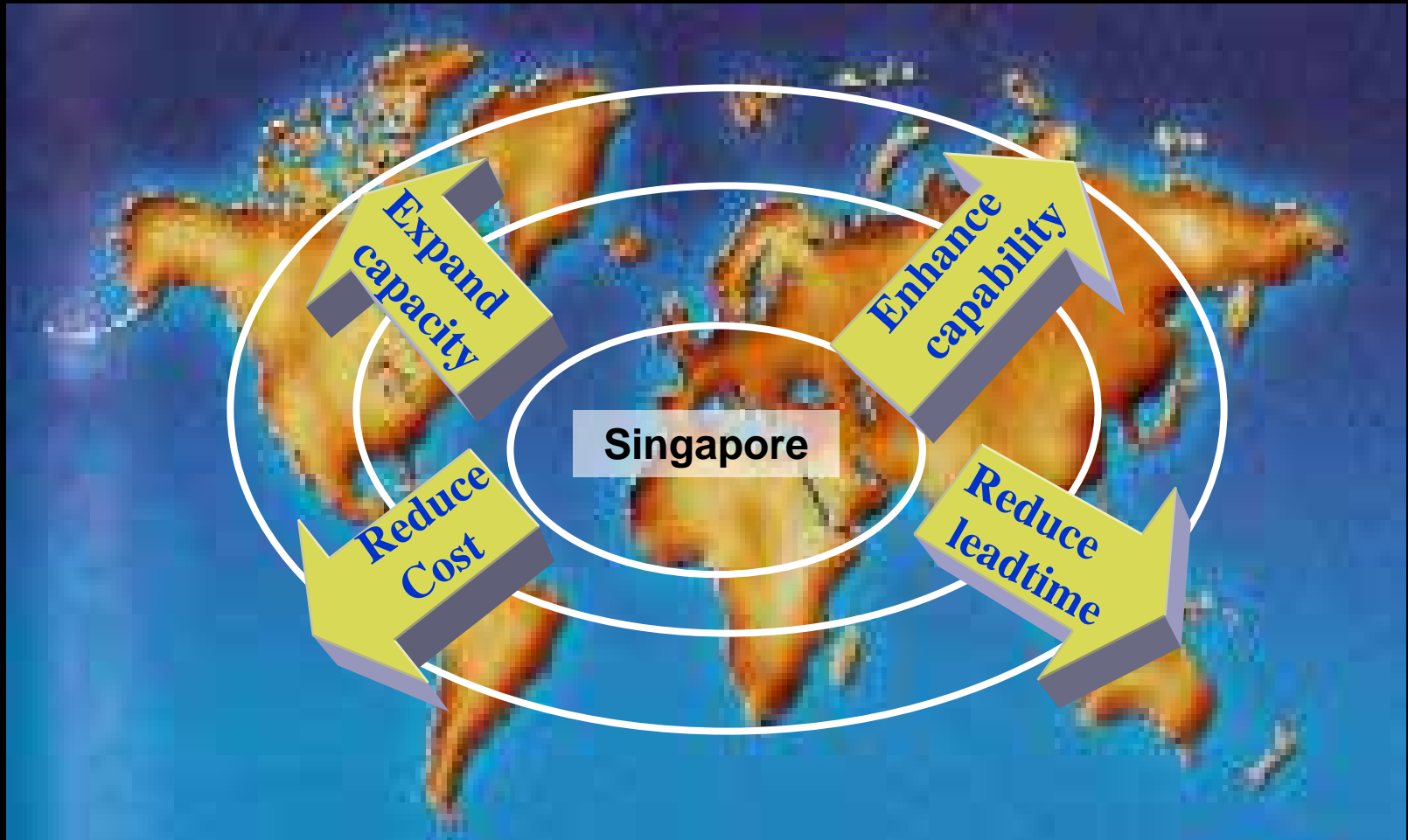
No. of Ships: 1251

Search Criteria: New Query

Sort Order

59°49'E 1°37'24"N TRACKS: 330

# Technology Collaboration

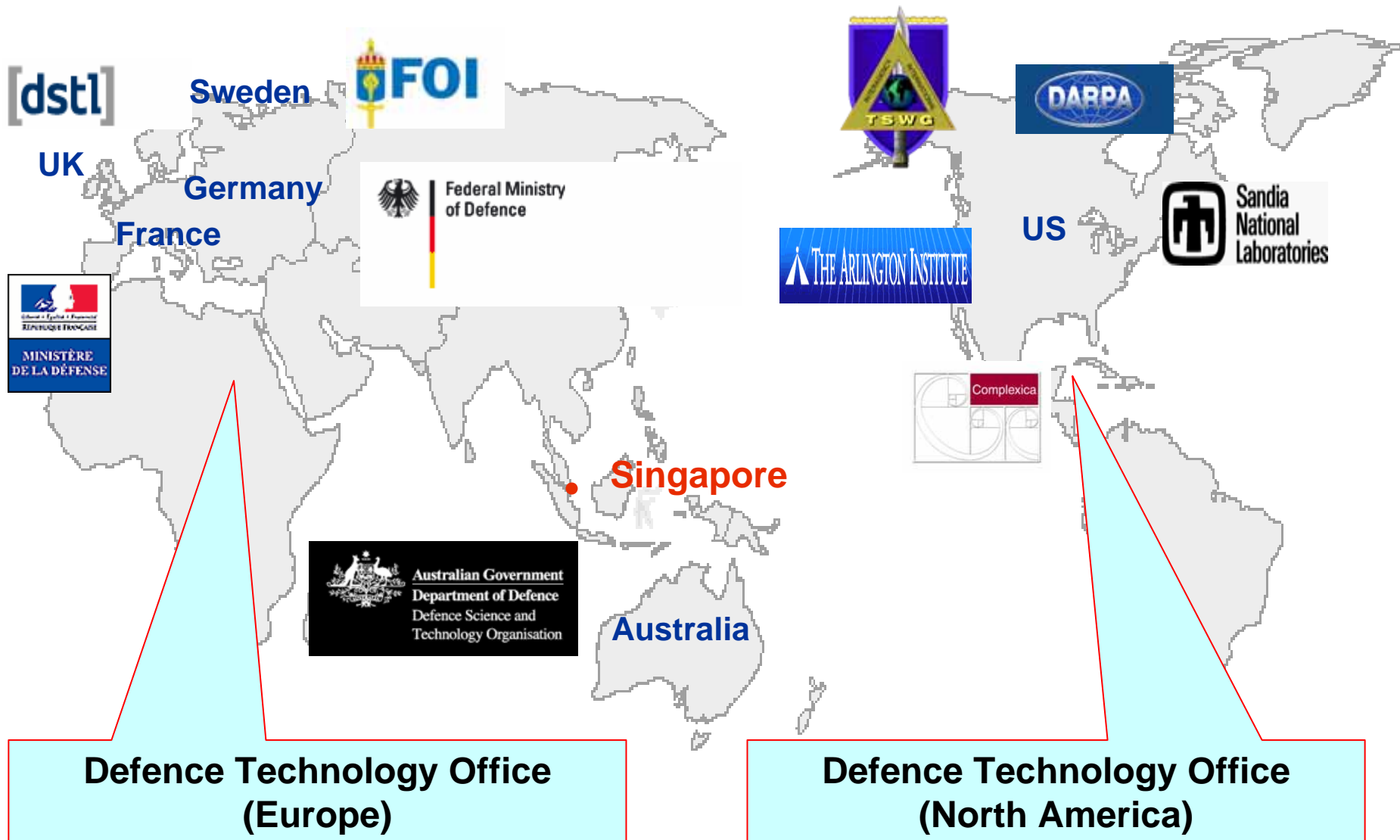




# Our S&T Partners



# International Collaboration



# Conclusion

- Singapore takes a systems level approach with technology as an enabler to meet the complex security challenges we face today
- Singapore participates in and seeks international collaboration to meet these challenges



Thank You



# NR

*Revolutionary Research . . . Relevant Results*

# **Naval Science and Technology Update**

## **PACOM Science and Technology Conference**

### **4 April 2007**





# A Technological “Perfect Storm”?



**For decades, Western militaries have held a decisive technological advantage...**



**“It is by devising new weapons, and above all by scientific leadership, that we shall best cope with the enemy’s superior strength.”**

**--Winston Churchill**

**Today, enemies are able to acquire weapons and technology quickly and cheaply...**



**“Acquiring weapons for the defense of Muslims is a religious duty. If I have indeed acquired these weapons, then I thank God for enabling me to do so. And if I seek to acquire these weapons, I am carrying out a duty. It would be a sin for Muslims not to try to possess the weapons that would prevent the infidels from inflicting harm on Muslims.”**

**--Osama bin Laden**

**And there also are nations willing to invest significantly in new technology...**



**“The 21<sup>st</sup> Century is also going to be an age of scientific change, with certain cutting-edge technologies likely to be applied to naval warfare...high-tech arms will make direct attacks on naval battlefields possible from outer space, remote altitudes and remote land bases...superconduction technology will bring superconductor ships to the naval order of battle, enabling ships to travel faster without noise...submarines will be able to go faster and deeper, with the seabed being the ideal place to build military bases.”**

**--Chinese Naval Officers at the Navy Research Institute in Beijing**





# Technological Dominance



**Laser-Guided Munitions**

**Today, Marines and Sailors have at their disposal the world's most sophisticated military technology**



**Mobile Communications**



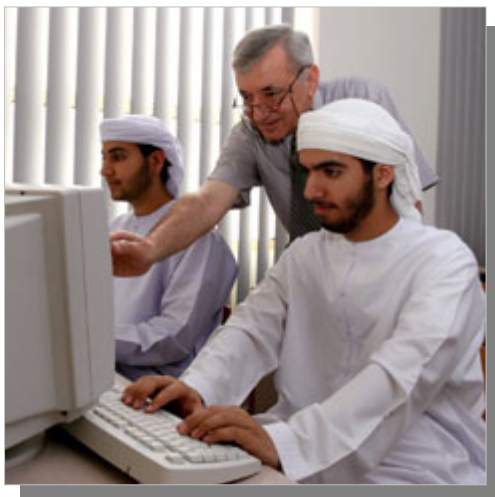
**GPS Navigation and Targeting**



**Network-Centricity, Information Warfare, and Intelligence**



# Technological Democratization



**Internet—  
Information Warfare  
and Intelligence**



**Commercial Laser  
Rangefinder—Precise  
Targeting**

**In Afghanistan, Iraq, and  
elsewhere, our adversaries are  
leveraging sophisticated technology  
that is now easily available  
anywhere in the world—  
and at modest cost.**



**Cell Phones—  
Mobile Comms**



**Handheld GPS—  
Location with  
Extreme Accuracy**





# S&T Strategy Objectives

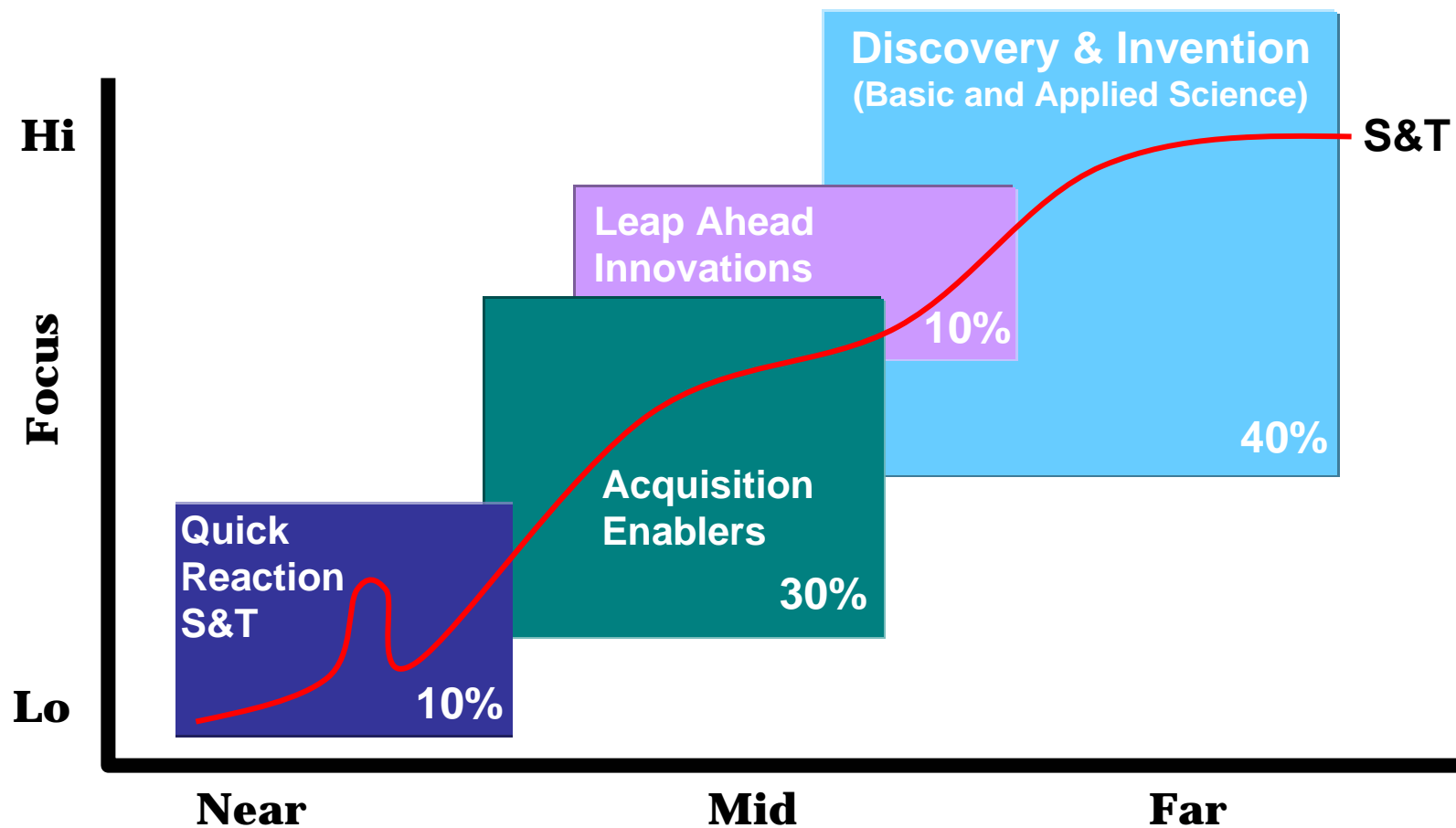


- **Ensure alignment of Naval S&T with Naval missions and future capability needs**
- **Balance and manage S&T portfolio based on key tenets:**
  - **Strive to engage with intellectual capital worldwide**
  - **Leverage U.S. and global technology insights**
  - **Maintain equilibrium between long-term basic research and near-term advanced prototyping**
  - **Be innovative and adaptive—lead science where it is critical to the Navy/Marine Corps vision**
  - **Leverage technology development efforts across the entire DoD**
- **Communicate S&T vision and approach to senior decision makers, key stakeholders, S&T partners, customers, and performers**





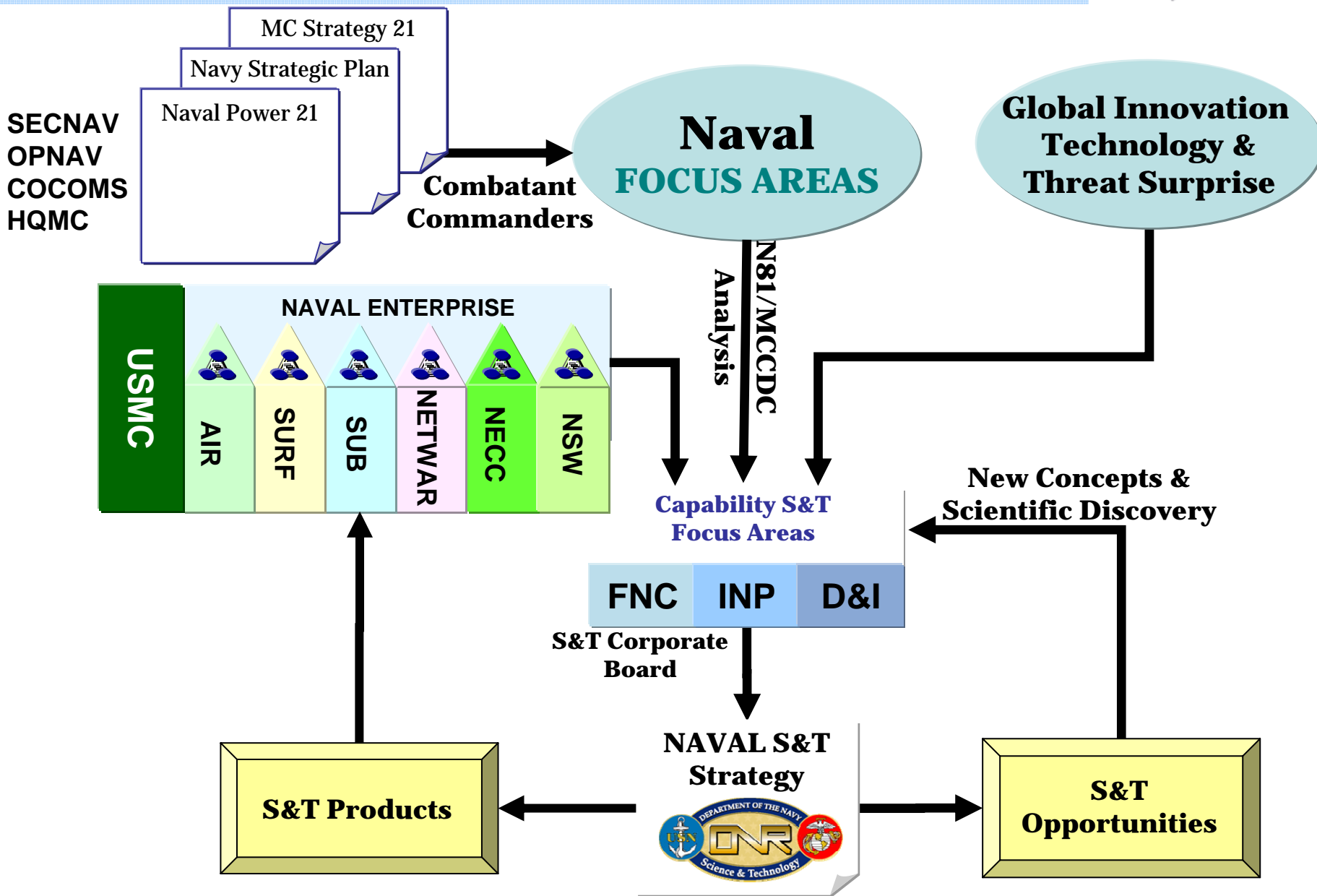
# ONR S&T Portfolio Balance



**S&T has a long-term focus but is responsive to near-term Naval needs**



# Naval S&T Strategy Process





# International Engagement

## **NORTHCOM:**

Canada  
Mexico  
Puerto Rico

## **EUCOM:**

Norway  
Sweden  
Finland  
Denmark  
U.K.  
Ireland  
Netherlands  
Belgium

France  
Spain  
Portugal  
Germany  
Italy  
Czech Rep.  
Slovakia  
Hungary  
Austria  
Slovenia  
Poland  
Romania  
Bulgaria  
Greece  
Estonia  
Tunisia

Latvia  
Lithuania  
Ukraine  
Russia  
Armenia  
Azerbaijan

Morocco  
Nigeria  
Cameroon  
Kenya  
South Africa

## **SOUTHCOM:**

Argentina  
Brazil  
Chile  
Columbia  
Panama  
Peru  
Uruguay

## **PACOM:**

Japan  
Korea  
Taiwan  
Vietnam  
Thailand  
Singapore  
Australia  
New Zealand  
India  
Mauritius

## **CENTCOM:**

Bahrain  
Pakistan  
Turkey  
Iraq  
Israel





# Resulting Naval S&T Focus Areas



- **Power and Energy**
- **Operational Environments**
- **Maritime Domain Awareness**
- **Asymmetric & Irregular Warfare**
- **Information, Analysis and Communication**
- **Power Projection**
- **Assure Access and Hold at Risk**
- **Distributed Operations**
- **Naval Warrior Performance and Protection**
- **Survivability and Self-Defense**
- **Platform Mobility**
- **Fleet/Force Sustainment**
- **Affordability, Maintainability, and Reliability**





# Assured Access and Hold at Risk



**Vision:** Attain maritime, littoral, and riverine access to denied areas and hold strategic and tactical targets at risk using lethal and non-lethal means.

## Objectives

### Anti-Submarine & Mine Warfare

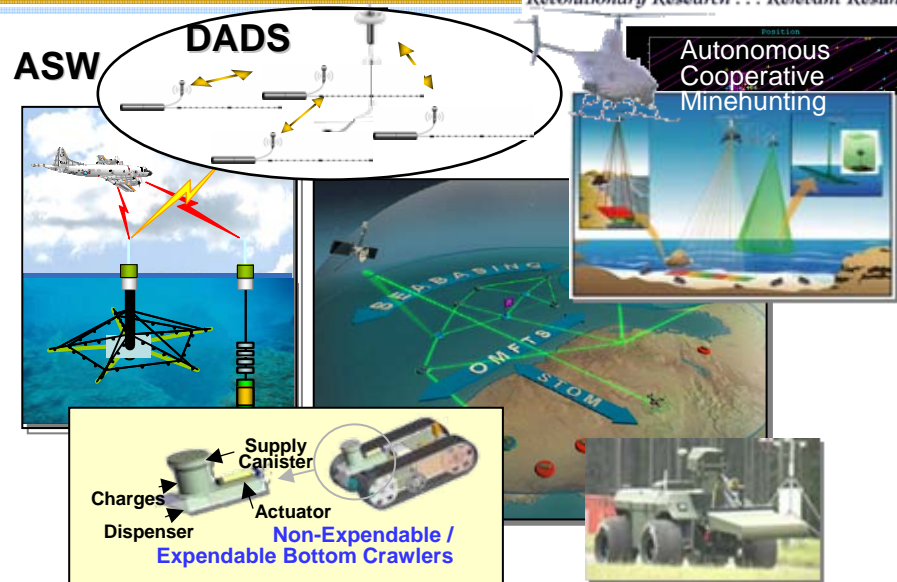
- Rapid Clearing and detection of mines
- Advanced autonomy in unmanned robotic systems to expand ground reach and reduce threat exposure
- Next generation data and contact fusion to expand the regional ASW, mine & amphibious warfare operating picture to the theater level

### Distributed Surveillance

- Distributed, networked surface, ground, and underwater sensors
- Unmanned systems with onboard processing
- Autonomous Maritime Reconnaissance/Neutralization

### Battlespace Shaping

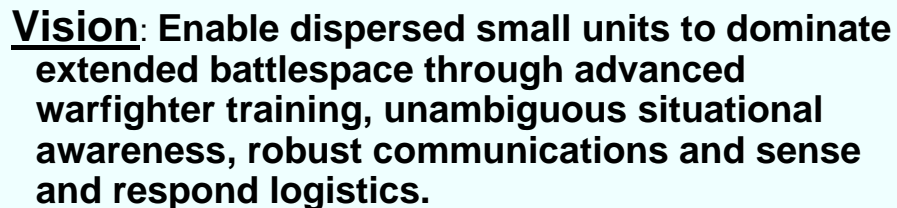
- Non-lethal technologies to stop small vehicles and large ships
- Battlespace shaping technology for enabling information operations
- Decisive operations through a heavy EW attack area
- Access in GPS denied areas – Alternatives to GPS technology
- Operationally responsive use of space
- Tagging, Tracking, and Locating Technologies



## Key Research Topics

Anti-Submarine Warfare Surveillance  
Mine Hunting  
Unmanned Vehicles  
Intelligent and Autonomous Systems  
Networked Sensors  
Space Technologies  
Nanoscale Electronic Devices & Sensors  
Solid State Electronics  
Functional Materials  
EW – Attack  
ISRT - EM  
Large Vessel Stopping  
Non-Lethal Weapons  
Navigation and Precision-Timekeeping





## Objectives

## Training

- Enhancement of Physical and Cognitive Performance
- Simulation – based scenarios for enhanced training
- Rapid assimilation of cultural environments

## Communications

- Robust Command and Control networks
- Airborne relays on manned and unmanned platforms

## Logistics

- Rapid re-supply and medical evacuation whenever possible
- Real-time automatic supply sensors and network
- Optimize medical self-sufficiency

## Fires

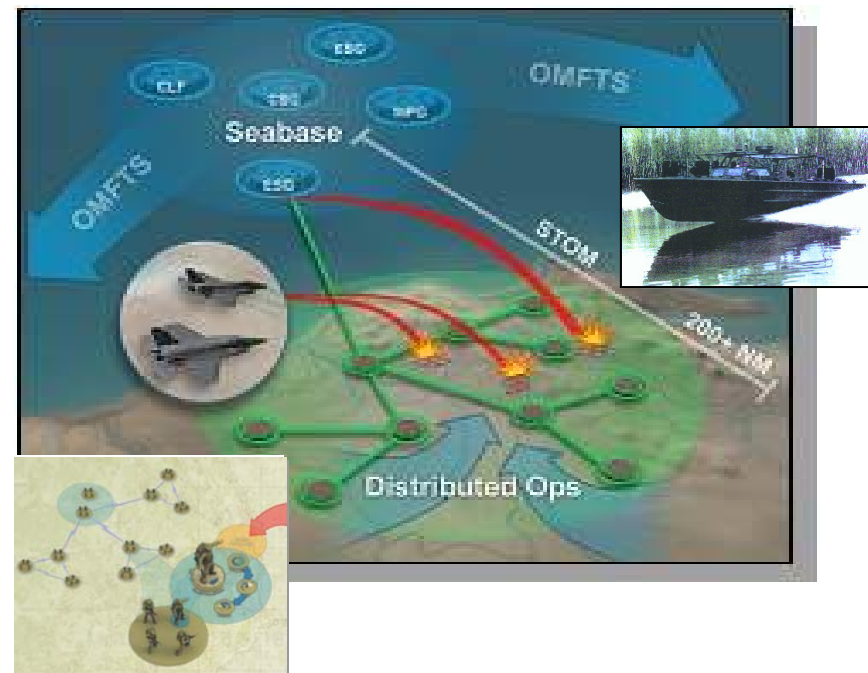
- Integrate firepower of distributed ground, offshore, and air assets
- Blue Force Tracking down to the individual

## Survivability

- Warfighter stealth technology
- Warfighter exoskeleton technology

## Maneuver

- Adaptable and survivable tactical mobility systems to enhance operational tempo and extend range of vehicles and soldiers
- Advanced materials to reduce combat load



## Key Research Topics

## Training, Education & Human Performance

## Expeditionary C4

## Communications and Networks

## Expeditionary Logistics

## Expeditionary Firepower

## Precision Strike

## Expeditionary ISR

## Unmanned Air and Ground Vehicles

## Special Warfare / EOD

## Land Mine Countermeasures

### Expeditionary Maneuver/ Individual Mobility





# Survivability and Self-Defense

**Vision:** Enable manned and unmanned platforms to operate in any hostile environment and avoid/survive attack through innovative materials, sensors, countermeasures and counter-weapons.

## Objectives

### Platform Stealth

- Reduce above water and subsurface signatures
- Multi-spectral LO technologies

### Countermeasures & Counterweapons

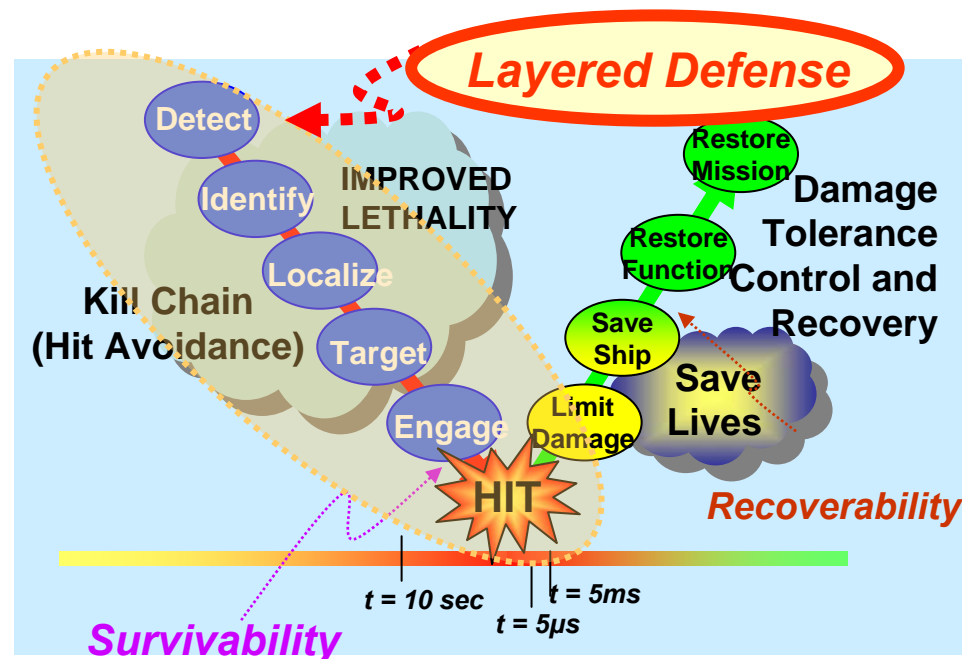
- Threat weapon tracking
- Automated decision making
- Low False alarm rate 360 degree detection
- Hard kill and soft kill against threat kinetic weapons
- Increase standoff to outside threat damage range
- Directed energy weapons for speed of light engagement
- Counter-LO

### Survivable Platforms

- Advanced materials in platform construction
- Damage tolerant platform architectures
- Automated damage control focusing
- Advanced materials for self healing platforms

### Force Protection

- Anti-swimmer technology
- Detect and determine threat intent
- Non-lethal response



## Key Research Topics

Signature Control (LO/CLO)  
Undersea Weaponry  
Torpedo Defense  
Directed Energy  
Survivable Platforms Structures  
Functional Materials  
Electro-Optics  
Solid State Electronics  
EW Attack  
ISRT – EM  
Expeditionary Force Protection  
Non-Lethal Weapons



# Future Naval Capabilities



The **Future Naval Capability** program is aligned with the pillars of Naval Power 21, and focuses on providing enabling capabilities to close warfighting gaps.

Examples of current (FY07) enabling capabilities and corresponding products in execution:

	FY05	FY06	FY07	FY08
<b>Products in Execution</b>	<b>129</b>	<b>119</b>	<b>114</b>	<b>112</b>
<b>Product Transitions</b>	<b>31</b>	<b>27</b>	<b>48</b>	<b>24</b>
<b>Enabling Capability Transitions</b>	<b>5</b>	<b>3</b>	<b>10</b>	<b>11</b>
<b>Enabling Capabilities in Execution</b>	<b>36</b>	<b>37</b>	<b>39</b>	<b>48</b>

Pillar	Enabling Capability	Products
<b>Sea Shield</b>	<i>Mine Countermeasures</i>	Communications and Navigation Aids for MCM Operations, Buried Mine Sensor Development for Detection and Classification of Buried Sea Mines
	<i>Over-the-Horizon Missile Defense</i>	Distributed Weapons Coordination, Advanced Area Defense Interceptor, Distributed Sensor Coordination
	<i>Defense of Harbor against Asymmetric Threats</i>	Intelligent Video Surveillance, Underwater Threat Neutralization, Passive Acoustic Fiber-Optic Array for Swimmer Detection, Terminal Swimmer Detection and Targeting
<b>Sea Strike</b>	<i>Advanced Naval Fires Technology</i>	Adaptive Expeditionary Maneuver Warfare System, Advanced Fires Coordination Technology, Advanced Gun Barrel Technology, Advanced Target Acquisition
	<i>Transparent Urban Structures</i>	Sensing Through Walls, Detect and ID Facilities, Decision Aids
	<i>Modular Scaleable Effects Weapons</i>	Scalable Effect Weapon Concept Development, Indirect Prototype (Scalable Effect)
<b>Sea Basing</b>	<i>Sea Base Mobility and Interfaces</i>	Small to Large Vessel At-Sea Transfer Sea Base Connector, High Speed Seabase-to-Shore Connector, High Rate Vertical / Horizontal Material Movement, High Lift Density Air Interface Ramp Technologies, Intra-Connector Material Handling
	<i>Surface Connector Vehicle Transfer</i>	
<b>FORCEnet:</b>	<i>Marine and UxV Tactical ISR</i>	Dynamic Replanning/Autonomous Vehicle Control, Fully Integrated Advanced Demonstrator Engine, Multi-Vehicle Cooperation / Targeting, Multi-Vehicle Networking / Comms Software
	<i>Global Information Grid-Compliant Networking</i>	High Altitude Airborne Relay and Router Package, Integrated, Autonomous Network Management, Intra-Battle Group Wireless Networking Block II
<b>Enterprise/ Platform Enablers</b>	<i>Compact Power Conversion Technologies</i>	Multi-Function Motor Drive, BiDirectional Power Control Module, Power Management Controllers
	<i>Maintenance Reduction Technologies</i>	Improved Non-Skid Coatings, High Performance Topside Coatings, Improved High Ship Rudder Coatings



# Making an Impact Today



## Modular Hybrid Pier

Modular, double-deck pier constructed of new corrosion-resistant concrete

- Demonstrated in FY05
- Transitioned to P327/N46 in FY07



## Intra-Battle Group Wireless Networking

High bandwidth, line-of-sight, wireless network within a battle group using existing advanced digital network system

- Block II transitioned to PMW160 in Dec 06
- Deployed on *John C. Stennis* strike group Jan 07

## QuikClot

Hemostatic agent that almost instantaneously stops severe arterial bleeding

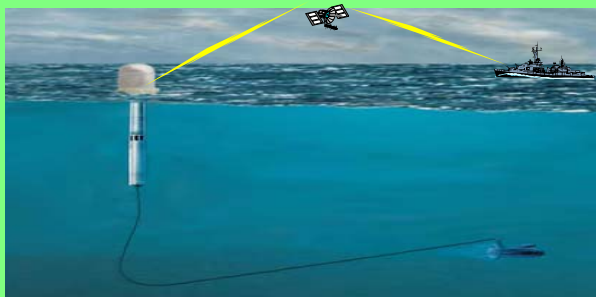
- Original product already in battlefield use with Marines
- FDA approval for Advanced Clotting Sponge expected in late FY07/early FY08



## Next Generation Submarine Comms at Depth

Two-way comms support submarine comms at depth

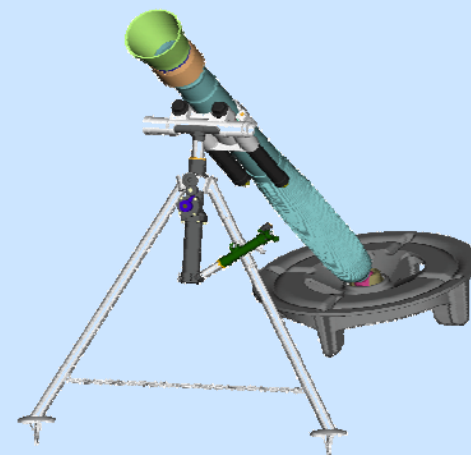
- At sea test in late FY07
- Transitions to PEO C4I PMW770 in FY08



## Lightweight Mortar System

Developed lightweight 81mm and 60mm mortar tubes base plates, and bipod assemblies

- Lightweight 81mm gun tube design transitioned FY06
- Lightweight 81mm bipod and base plate and 60mm mortar systems designs transitioned FY07







# Innovative Naval Prototypes

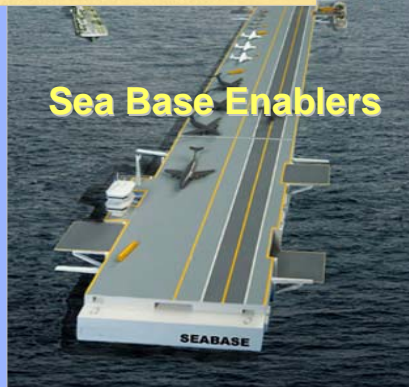


## Current INPs

**Electromagnetic Rail Gun**



**Sea Base Enablers**



**Persistent Littoral Undersea Surveillance**



**Tactical Satellite**

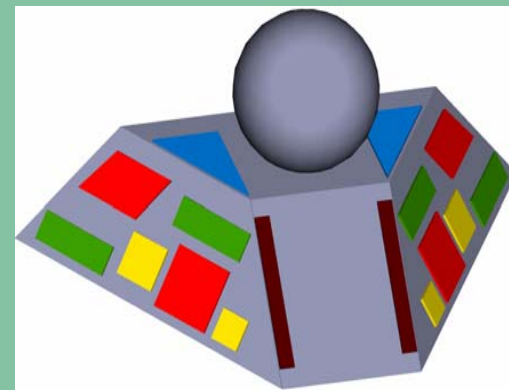


## Potential INPs

**Free Electron Laser**

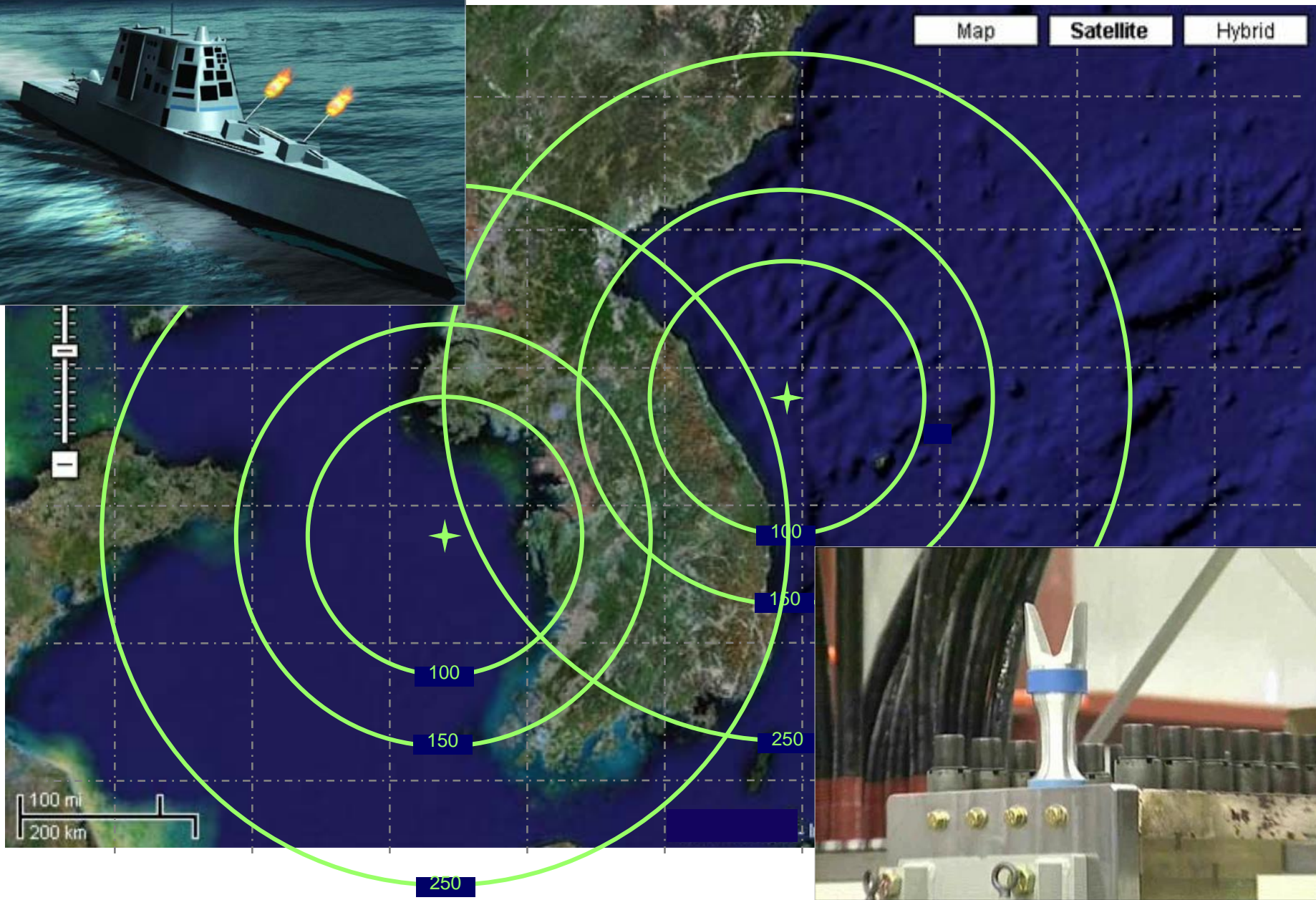


**Integrated Digital Apertures and Array Radars**





# Electromagnetic Rail Gun





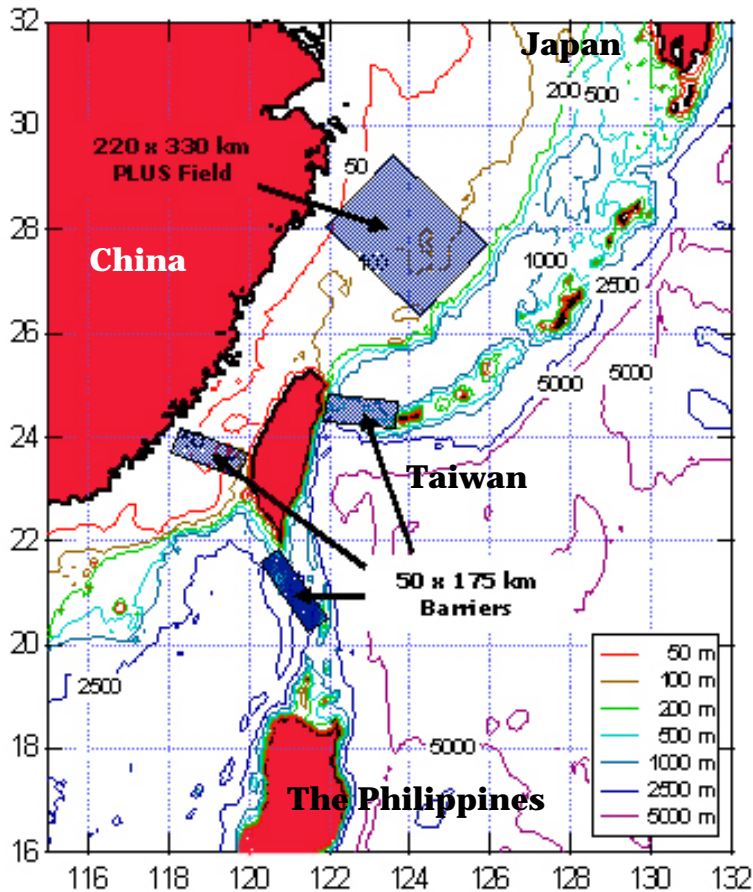




# Persistent Littoral Undersea Surveillance (PLUS)

## Mission:

Hold-at-Risk ASW strategy requires effective undersea surveillance against multiple, quiet targets over large littoral areas (100 x 100 nm) for months



## Game Changing

- Inverts ASW asymmetry using autonomous, mobile, controllable sensor/weapon network
- Adapts to environment, targets, and threats
- Persists clandestinely for months
- Autonomous self deployment

## Innovative Elements

- Autonomous, cooperative behavior among structured, mobile sensors (gliders, mobile scanning arrays, intervention units)
- Feedback control to meet operational detection thresholds
- Adaptive target closures yielding actionable kill chain



# A Swiftly Changing Planet



- In an era of increasing globalization, new technology is more readily available—and more quickly—than ever before
- The natures of “combatant” and “weapon” are changing, and new challenges can come from anywhere in the world

- We must accept the fact that adversaries will use our technology against us
- To stay competitive on tomorrow’s battlefields, we must:
  - **Ensure** our people and research enterprises are more innovative
  - **Maintain** our technological advantage





# Questions?



***If technology doesn't seem like magic—it's probably obsolete.***